specific gravity of the oil used from year to year (from 1.071 in 1902 to 1.116 at 38° C. in 1914).

Some radical departures from the 1914 specifications were made in the revised specifications for wood-block pavements. These will be published by the society, although not yet adopted. The subcommittee on wood-block pavement recognized pure distillate oil as a satisfactory preservative, but did not recommend its adoption at this time. Changes are made in the specification as to the sizes of blocks—8 in. is to be the average length, 4 in. the depth for heavy traffic, 3½ in. for medium traffic and 3 in. for light traffic; but no blocks 3 in. in depth are to be longer than 8 in. The clauses defining the preservative oil are so drawn as to admit a pure distillate oil (specific gravity 1.06 to 1.12 at 38° C.) and are otherwise broadened. Only coal-gas or coke-oven tar may be used. Special precaution is to be taken to have the sapwood thoroughly penetrated. Steaming is to be carried on for 2 hr. and the vacuum maintained for 10 min. Clauses have been added to the specifications requiring the blocks to be so piled on the work as to prevent their drying out. The blocks are to be wet before laying and are to be laid with close joints instead of with loose joints, as previously specified. The joint filler may be either sand or coal tar.

Sheet Asphalt and Asphaltic Concrete

The repair of asphalt pavements in small cities by reheating and utilizing storage mixtures made when the pavement was laid, similar to the methods used at Charlotte, N. C. (*Engineering News*, Feb. 11, 1915), was described in a paper by W. H. Taylor, Jr., City Engineer of Norfolk, Va. The paper also described in detail an experimental home-made asphalt plant which is being successfully used for working over material removed from old asphalt pavements. This material, reheated and with the addition of some new asphalt, is used for making repairs to other pavements. The total cost is 40.2c. per sq.yd. for taking up, reheating and relaying the old mixture.

Types of bituminous-pavement construction and their limitations were discussed by Francis P. Smith, New York City. His conclusions seemed to be that the penetration method of construction was doomed to be abandoned, that where heavy traffic was to be carried a hot-mixed pavement was to be preferred to a cold-mixed one, that sheet asphalt is the preferable type of bituminous pavement for city streets and that pavements constructed according to the Topeka specification are unsatisfactory.

The majority report of the subcommittee on bituminous paving recommended a continuation of the 1914 specifications, with a footnote to the effect that the use of one of the two specifications given might involve the city in patent litigation. A minority report of the subcommittee recommended the adoption of the Warren Brothers Co. bitulithic specification and a modified form of the Topeka specification. The minority report was adopted, as previously noted. Independent of either of these is a third specification drawn by the subcommittee on broken-stone and gravel roads (Prof. A. H. Blanchard, New York City, chairman) for an asphaltic concrete pavement utilizing one product of a crushing plant—a specification similar to that under which the Catskill water-supply roads, described in *Engineering News* of Nov. 5, 1914, and the Rhode Island state roads have been constructed. This report was also adopted by the society.

Concrete Pavements on Street-Car Area

The subcommittee on concrete pavements adopted specifications for one-course and two-course pavements, which are based largely on the specifications of the American Concrete Institute, with some quite important changes, however, in regard to the coarse aggregate and the proportions of the mixture. These specifications were tentatively adopted by the society.

The maintenance of the pavement in the street-railway area was the subject of a paper by N. S. Sprague, Pittsburgh, Penn. Mr. Sprague believes that cities should take over the maintenance of the pavement in the railway area and be reimbursed in some way by the railway companies.

Garbage Disposal and Street Cleaning

In the papers and discussions on garbage disposal the fact was established that the majority of cities show little interest in this branch of municipal work. A large number of reduction plants are privately owned and no data on their operation are available. In a paper by B. F. Miller, City Engineer of Meadville, Penn., "Data on Garbage Reduction and Disposal," it was stated that collection is the largest item in the cost of garbage disposal. The most recent developments, according to Mr. Miller, are in high-temperature incinerators, which are proving satisfactory in several places.

Plans for a $55,000 municipal reduction plant, at Dayton, now under construction, were described by J. E. Barlow, Director of Public Service. Since June, 1914, the garbage of the city has been buried under gravel. Arrangements have been made for the sale of grease, and it is believed that the new plant can be made to pay all operating expenses.

Water-Supply and Sewerage

A detailed description of the new water-supply for Victoria, B. C., was given in a paper by C. H. Rust, City Engineer. One of the most interesting features is a 42-in. concrete pipe line 144,000 ft. long. The reconstruction of the water-works of Hamilton, Ont., was described by A. F. Macallum, City Engineer of Hamilton.

The most interesting subject under the head of sewage disposal was a description by T. Chalkley Hatton, Chief Engineer, Milwaukee Sewerage Commission, of the new experimental plant at Milwaukee, Wis., for treating sewage by the activated-sludge method (*Engineering News*, July 15, 1915). Mr. Hatton believes that the activated-sludge process is "the best and cheapest process for treating sewage, where a high standard of effluent is required, and as it becomes better developed it will supplant sedimentation and sprinkling filters."

In discussing this paper Rudolph Hering, while commending the breadth and scope of the Milwaukee experiments, expressed doubt as to the success of the method in winter weather.

The paper of George H. Norton, Buffalo, N. Y., on "Stream Pollution from Surface Drainage as a Limiting Factor in Sewage Purification," dealt with the futility of trying to obtain pure lake water by purifying the sewage of cities beyond the point where an equal amount

of pollution was derived from ordinary surface waters entering the lake. In the report of the committee on sewerage and sanitation the same necessity for sound judgment on the part of the engineer was emphasized. The report gave an analysis from a mathematical and pecuniary standpoint of various public-health measures—comparing the cost of saving human life by sanitation and by hospital treatment—to demonstrate that these problems were capable of engineering analysis and that such analysis could be used to prevent needless and extravagant expenditures for sentimental reasons.

Municipal Government and Finance

Henry M. Waite, City Manager of Dayton, gave a brief address on the Dayton plan of city government.

Other papers which had to do with problems of municipal government were: "The Law and the Public Welfare," by William S. Crandall, Dayton; "The City at Work," by Louis L. Tribus, Consulting Engineer, New York City, and "Obligations of the State to the Municipality in Matters of Public Works," by Alexander Potter, Consulting Engineer, New York City, in which the author took the stand that various state commissions were exerting power to the detriment of municipal public works.

Committee Reports—Officers—Next Convention

On the recommendation of the committee on committees the list of standing committees of the society was extended so that there are now twelve: (1) Paving, (2) sidewalks and street design, (3) city planning, (4) parks and parkways, (5) street lighting, (6) traffic and transportation (to include street-railway problems), (7) waterworks, (8) sewerage and sanitation, (9) street cleaning, (10) city government, (11) standard specifications and (12) exhibition committee of three associate members.

The report of the committee on street paving favored the discouragement of road improvement by large expenditures on a few miles of road, to the exclusion of many miles on which some improvement could be made for the same expenditure. The report stated that more cooperation between the state, county and town or city in roadbuilding was desirable. The committee on sewer construction and maintenance attempted to define the terms used in sewer work, but none of these were unusual except the objection to the term "sanitary sewer," in place of which "house sewer" is recommended. The report of the committee on traffic on streets aroused considerable discussion—mainly with the end in view of determining if traffic censuses were put to practical use and if traffic censuses by different authorities were comparable. The committee on standard specifications has decided that hereafter the society's specifications can be used only by cities represented in the membership or themselves belonging to the society.

The following officers were elected: President, A. F. Macallum, City Engineer, Hamilton, Ont.; first vice-president, N. S. Sprague, Pittsburgh, Penn.; second vice-president, John B. Hittell, Chicago, Ill.; third vice-president, E. R. Conant, Savannah, Ga.; secretary, C. C. Brown, Indianapolis, Ind.; treasurer, William B. Howe, Concord, N. H. The place chosen for the next convention was Newark, N. J.

News of the Engineering World

A Chief Engineer for Baltimore

The latest, and a most notable, example of centralizing the engineering work of a city and creating a position which will attract and hold an engineer of experience and capacity is afforded by the City of Baltimore, which has just honored Calvin W. Hendrick, Chief Engineer of the Baltimore Sewerage Commission, by making him Chief Engineer of that city. How this came about and just what it means, both in itself and in relation to the Sewerage Commission, can best be told in Mr. Hendrick's own words, in a letter to *Engineering News:*

At the last session of the Legislature a new adjustment of the engineering forces of the city was arranged for, creating the position of Chief Engineer and placing the various departments of the city under him, as follows: Highways Department, Commission on City Plan, Topographical Survey Commission, Sewers, Paving, Annex Improvement, Electrical Commission, Water Board, Harbor Board, Inspector of Buildings and City Surveyor.

Until Jan. 1 I will occupy both the positions of Chief Engineer of the city and Chief Engineer of the Sewerage Commission. By that time I will have the sewerage work completed, with the exception of winding up several contracts, which will require a couple of months. About Apr. 1 the Sewerage Commission will go out of existence and its duties will then come under the Chief Engineer and be carried out under the Bureau of Sewers.

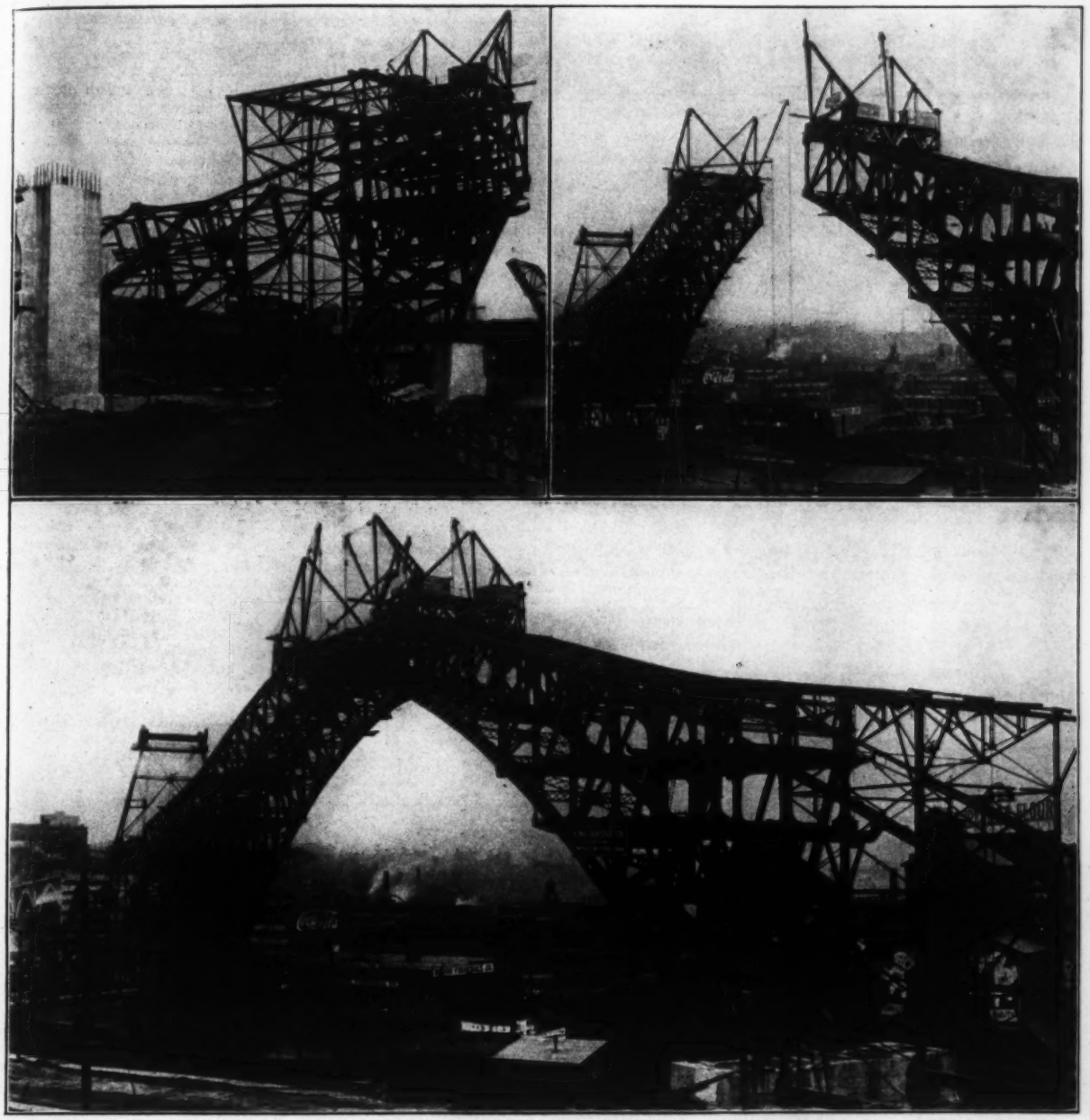
The Chief Engineer is given very broad powers under the new arrangement. The City Engineer's office has been abolished entirely.

Second Exhibition of Street-Cleaning Apparatus

The Second Annual Exhibition of Street-Cleaning Appliances, held under the auspices of the Department of Street Cleaning, City of New York, was held at the First Regiment Field Artillery Armory in New York City during the week of Oct. 11 to 16. The Department had on display some of its more novel and interesting pieces of apparatus. Various manufacturers had exhibits also.

Among the more notable pieces of equipment shown were motor-truck sprinklers, sand spreaders, ash wagons with power lifts, dustless refuse cars, odorless garbage trucks, pavement flushers and cleaners, snow-plow attachments for motor trucks, etc. There was a good representation of the more familiar street-cleaning equipment and of domestic novelties such as odorless garbage cans, etc.

One of the machines which attracted great attention was a tractor-trailer outfit of the Department of Street Cleaning, having eight removable square bell-top cans and holding 10½ cu.yd. of ashes and garbage or 13 cu.yd. of rubbish. In service the cans are lifted out by a crane and dumped on scows. Perhaps the most novel machine displayed was a motorcycle street sweeper (made by Hvass & Co., New York City).



THE 591-FT. STEEL ARCH OF THE DETROIT-SUPERIOR BRIDGE IN CLEVELAND CLOSED OCT. 8

Closing Detroit-Superior Arch

Third largest among steel arches of the United States, the 591-ft. span of the Detroit-Superior viaduct in Cleveland, crossing the Cuyahoga River, was successfully closed on Oct. 8. The two halves of the span were erected by the cantilever method, with anchorage on either side to the concrete pier of the viaduct, one span back of the main arch abutment.

In general method of erection the construction of this arch was the same as that of the Hell Gate arch, the closure of which on Oct. 1 was noted in *Engineering News*, Oct. 7, 1915. But the adjustment of the Detroit-Superior arch was provided for by screw toggles in the backstays, while at Hell Gate hydraulic jacks under the backstay saddles were employed. One of the toggles shows clearly in the first view on this page.

The first steel set in the east half of the Detroit-Superior arch was placed July 29, as described in *Engineering News*, Aug. 5, 1915, p. 283. Erection of the east arm was carried on rather slowly during the first month, however, pending the start of work on the west arm, which was delayed by the fact that the west pier was not completed. On Aug. 27 the first steel of the west arm was set. Only 37 working days later the center pin was placed.

The two toggles of each arm—one in the plane of either truss—were cross-coupled by a transverse shaft and operated by means of this shaft, driven by a rope wheel at the center of the shaft. This made both toggles act together. During the lowering, telephone communication was maintained between the working places on both sides of the river and the crown point, and as a result the en-

tire operation was uniform and under control at all times. The time consumed in lowering to full contact and entirely relieving the backstays was 1 hr. 30 min.

The span is designed as a three-hinged arch, with span 591 ft. and rise 144 ft. c. to c. of pins. The bridge will have two decks—the lower for six street-car tracks and the upper for street traffic. The arch members are of nickel steel, while the floor and bracing are of carbon steel. The completed structure will contain about 4,250 tons of metal.

The work was fabricated by the King Bridge Co., Cleveland, Ohio, of which Harry Fuller is Chief Engineer. This company contracted for both manufacture and erection of the steel span and designed and manufactured the erection material. The erection was performed by the Ferro Construction Co., of Chicago, subcontractor under the King Bridge Co. The bridge is being built for Cuyahoga County, of which W. A. Stinchcomb is County Engineer and A. W. Zesiger Bridge Engineer.

Value of Denver Water-Works

A valuation of $13,415,899 has been placed on the "used and useful" property of the Denver Union Water Co. by W. J. Chinn, special master of the United States Circuit Court in the water-rate reduction case started in May, 1914. The 20% reduction in rates proposed by the city ordinance at issue, Mr. Chinn states, would yield only 3.64% on the valuation named, based on last year's operations. The water rights are valued at about $3,000,000 and the going-concern value is placed at $800,000—two items over which there was the greatest controversy. Another interesting point in the report is the exclusion from the valuation of the cost of pavement over mains, where such pavement was laid after the mains were in place. Corporation costs were also excluded from the valuation. In general the estimates were based upon the present fair market value of adjacent lands and water rights and on reproduction cost less depreciation for structures.

Another Subway-Collapse Report

In addition to the reports noted in these pages Oct. 7 and Oct. 14, a report on the subway timbering accidents in New York City Sept. 22 and Sept. 25 has been made to the Mayor by L. M. Wallstein, Commissioner of Accounts. This report places strong blame on the loose construction of the timbering:

As to the physical causes of the accidents, my conclusions as to both are, that the progressive collapse of roadway was due to inadequate supporting structure beneath the surface. At Seventh Ave. the collapse was initiated by the impact of rocks hurled by a blast against part of the temporary supporting structure, and at Broadway by the impact of rocks which fell from the side of the excavation against part of the temporary supporting structure.

The method of timbering in use by the United States Realty and Improvement Co., described in *Engineering News* Sept. 30, is discussed as follows:

It will be noted with reference to this timbering that there was no cross-bracing in any direction. Other than the tie between the transverse I-beams, there were no ties in any direction. There was no fastening between the steel I-beams and either the main posts below or the posts above them. Nor was there any fastening between the posts below and those above the I-beams. Further, there was no adequate bracing between the transverse I-beams themselves to prevent overturning, and there were no longitudinal timbers between the outside main posts.

In a word, this timbering consisted of a combination of wood and steel loosely connected. Above the steel the timbering was arranged to suit the street and subsurface structures. Below the steel the posts were spaced to give a maximum facility to excavating operations. Neither above the steel nor below it were there any adequate precautions against transverse or longitudinal displacement of the timbering. As a result, the knocking out of any post below the steel or of any steel beam was sufficient to collapse the whole structure.

The method of timbering used in this section of subway construction (7th Ave. between 24th and 25th St.) was different from that employed on any other part of the dual system, except the Broadway section. It was entirely unsuited for the purpose for which it was designed.

With the timbering thus inviting failure, there followed on the morning of Sept. 22 the blast which precipitated the collapse. During the day preceding the accident holes had been drilled in preparation for the blasting to be done on the following morning. Among these were four holes on the east side of the heading. The hole farthest east ran into a long and generally horizontal seam in the rock. The next hole ran into a vertical seam. The four holes, which were fired simultaneously, were loaded with a charge which normally would not have been excessive. The effect, however, of the rock seams was to render excessive the charges which were loaded in the holes that ran into the seams. The result, accordingly, was that the greater part of the force of the dynamite was expended not in fracturing the rock but in breaking it into large fragments and hurling them into the cut and against adjacent parts of the timbering. A large depression in the web of the nearest transverse steel beam clearly showed the effect of the impact of the rock against the beam. Here then was just the kind of attack upon the temporary supporting structure which it was unable to withstand, so that it collapsed from the north heading southward to the concrete walls and steel structure, which were part of the permanent work.

ENGINEERING SCHOOLS

Ohio State University

A four-year course in landscape architecture is being offered for the first time at this institution. The work is under the Department of Horticulture, with P. H. Elwood in active charge. Some of the courses will be given by A. E. Taylor, landscape architect, of Cleveland.

Beginning in 1917, students entering this university will be required to spend two years in the Arts College before being admitted to the schools of engineering, agriculture, etc. Presumably this change will be accompanied by a reduction of the professional courses to three or two years.

Yale University

An organization of Yale graduates engaged in engineering, manufacturing and transportation, known as the Yale Engineering Association, has recently been completed. Its objects are to help the university's educational work (by recommendations about courses, by conferences with faculties, alumni visits, engineering lectures to undergraduates, etc.), to establish helpful relations between Yale men (by joint meetings, visits to work under Yale graduates, obtaining positions for young graduates, finding summer work for undergraduates), to carry on publicity work, to coöperate with other college associations and national engineering societies, and to study engineering education.

The officers are: President, E. M. Herr, Westinghouse Electric and Manufacturing Co., Pittsburgh; Vice-President, H. N. Covell, Lidgerwood Manufacturing Co., Brooklyn, N. Y.; Secretary-Treasurer, R. T. Dana, Consulting Engineer, New York City.

NEWS NOTES

St. Louis Municipal Bridge Labor Disputes—In compliance with an agreement between the city and the union-labor interests in St. Louis an arbitration commission has been appointed to adjust the differences between the union and the city. On this commission a Mr. Haenni is appointed by the unions, C. E. Smith, former Chief Engineer of the Missouri Pacific Ry., by the Board of Public Service and these two selected R. S. Colnon, of the contracting firm of Fruin & Colnon and an associate member of the American Society of Civil Engineers, as the third party. The first matter referred to this commission was the demand of the unions that the city superintendents be discharged, which was refused on the ground that they had been appointed by competent engineers and were familiar with the particular class of work. In this connection the board also announced that it would not consider the question of discharges for incompetency, as it felt that the particular foremen were better qualified than the board to pass on that point. As to jurisdictional troubles between the various unions, the board has announced that it will consider these matters on their merits under the conditions existing on this particular work and expect to rule as to what is reasonable rather than to insist on the city following any general rules of the union, which may not be applicable to the work. The city ordered a full force of union men to report for work on Oct. 18.

The Panama Canal Situation has not changed since last week. Under date of Oct. 12 the Governor of the Canal reports as follows:

The mass of material involved in the break of Oct. 14, 1914, which had been sliding gradually into the prism, moved precipitately. This combined with a similar movement from the break which occurred just opposite on the west bank in August causes the present conditions. The length of channel involved 1,300 ft., of which 200 ft. at present has a width of only 25 ft. and a depth of 3 to 15 ft. For the week ended Oct. 9, 209,000 cu.yd. of material was dredged; but as the movement continued the result has been to maintain only what the slides left in the first instance. The canal is therefore physically closed temporarily. On the east side the bank is upward of 300 ft. above canal level and on the west side varies from 300 to 400 ft. above. Material in settling and moving creates earth waves with deep depressions behind, these being some 500 to 600 ft. from the canal prism, with elevations of 60 to 80 ft. above water surface. These waves undoubtedly counterbalance the weight of the broken mass on either side and when removed may cause another similar movement; hence the impossibility of making any prediction as to the date of opening until after the waves which now block the channel have been removed and action of remaining material determined. Heavy rains materially affect the movement. Whether light-draft ships can pass in advance of 30-ft. draft ships must depend on conditions when a reasonably secure channel is attained.

The general slide conditions do not seem to be radically changed from what they were in 1914, as described by W. G. Comber in "Engineering News" of Apr. 22, 1915.

PERSONALS

Mr. Jay A. Rossitter has been appointed Engineer of Track Elevation for the City of Chicago.

Messrs. John Laylin, Assoc. M. Am. Soc. C. E., of Norfolk, and Ted Brindle, of Columbus, Division Engineers of the Ohio State Highway Department, have resigned from that department.

Mr. J. D. Bowles, recently Engineer of the Missouri Public Service Commission, has been appointed Electrical Engineer of the Springfield (Mo.) Gas and Electric Co. Mr. Bowles succeeds O. S. Clements, who recently resigned.

Mr. Orville Wright, who recently sold his aëroplane patent rights to the newly organized Wright Aëroplane Co., will continue with the company in the capacity of advisory engineer. Mr. T. Frank Manville is president of the company.

Gen. H. M. Chittenden, U. S. A., retired, M. Am. Soc. C. E., has resigned as a member of the Seattle Port Commission. He is now located at Dayton, Ohio, where he is engaged as consulting engineer on the flood-prevention work in the Miami River district.

Mr. A. H. Spahr, Instructor in Engineering Extension at the School of Engineering, Pennsylvania State College, has been appointed Professor of Physics at the Kansas State Normal School, Pittsburg, Kan. Mr. C. F. Kopp, of Amite, La., will succeed Mr. Spahr.

Mr. Alan A. Wood, Jun. Am. Soc. M. E., who has been connected with the venturi-meter department of the Builders Iron Foundry at Providence, R. I., is now located with the company's Pacific Coast agent, Norman B. Livermore & Co., at San Francisco and Los Angeles, in an engineering and sales capacity.

Mr. Harvey W. Hincks, Assistant Engineer of the United States Indian Irrigation Service, has been made Engineer in the Service. He is in charge of the Klamath Indian Reservation irrigation work, with headquarters at Chiloquin, Ore. Mr. Hincks recently supervised the construction of the Modoc Point Irrigation Project and the Sprague River Dam.

Mr. Myron L. Fuller, who has been in China for nearly two years, engaged in exploration work, has returned to this country and will again take up his consulting practice as a specialist on ground-water supplies and dam foundations. Correspondence will reach Mr. Fuller in care of the Bureau of Associated Geological Engineers, 131 State St., Boston, Mass.

Mr. Alvin Bugbee, M. Am. Soc. C. E., Superintendent of Water-Works of Trenton, N. J., who has been Acting Chief Engineer of the water-works since the death of George W. Lenox, about six months ago, has assumed the duties of chief engineer in addition to his superintendency. The assignment of the duties to Mr. Bugbee was made recently by the City Commission of Trenton and the position of Chief Engineer abolished. Mr. Bugbee will receive a slight increase in salary.

Prof. James Ambrose Moyer, M. Am. Soc. M. E., head of the Department of Mechanical Engineering of Pennsylvania State College, has been appointed Director of the University Extension of the State of Massachusetts, which is a new department. Professor Moyer has been connected with the General Electric Co. as mechanical engineer and chief computer, and the Westinghouse, Church, Kerr Co. as general engineer, and recently has been director of engineering extension work and acting director of the Engineering Experiment Station of Pennsylvania State College.

OBITUARY

Thomas P. Fowler, formerly President of the New York, Ontario & Western Ry., died on Oct. 13 at his home in Warwick, N. Y. He was born in Newburgh, N. Y., in 1851.

Edward D. White, for 27 yr. connected with the Brooklyn (N. Y.) City R.R. Co. and for 19 yr. Vice-President, died on Oct. 14 at his home in Brooklyn, in his 94th year. Mr. White retired from the board of directors of the company only this year.

William B. King, M. Am. Soc. C. E., General Manager of the Fort Worth (Tex.) Stock Yards Co. and the Fort Worth Belt Ry., died on Oct. 11 at his home in that city at 65 years of age. He was born in Virginia and went to Texas when a young man, settling in Weatherford. Afterward he became City Engineer of Fort Worth and of Weatherford. At various times Mr. King was resident engineer at Fort Worth for several of the Texas railways and was in charge of the construction of the Texas and Pacific Ry. between Fort Worth and El Paso. Later he established the Fort Worth Stock Yards Co.

ENGINEERING SOCIETIES

COMING MEETINGS

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS. Oct. 18-24. Annual meeting in Chicago. Secretary, J. A. Andrencetti, C. & N. W. Ry., Chicago, Ill.

The Engineers' Club of Trenton—Following the lead of many other engineering organizations, the Engineers Club of Trenton has established an employment bureau to be managed by the secretary, Joseph E. English.

American Association of Engineers—All engineering societies have been invited to send official representatives to the convention of the American Association of Engineers, to be held in Chicago, Dec. 10 and 11. The Association announces that 55 new members were gained during the latter half of September. The chairman of the National Membership Committee is A. H. Krom, Assistant Engineer, State Public Utilities Commission of Illinois.

A Large Mining Convention will be held in Washington, D. C., on Dec. 16, to act on recommendations regarding a general revision of the Federal mining laws. Van H. Manning, Director of the Bureau of Mines, announces that all the known mining societies in the United States have been invited to send delegates. It is hoped that the mining industry will be so well represented that the action of the convention will be regarded as expressing the wishes of the industry.

American Institute of Electrical Engineers—The 314th meeting of the Institute and the 100th meeting of the St. Louis section were held simultaneously at the Planters Hotel, St. Louis, Oct. 19 and 20. Out-of-town members of the A. I. E. E. were guests of the St. Louis Section at a luncheon held on Oct. 19 and were entertained at dinner on Oct. 20 by the St. Louis Engineers' Club. This was followed by a theater party. The meeting was the first national meeting of the Institute held in St. Louis since the World's Fair, 11 yr. ago.

Boston Society of Civil Engineers—That the social element is not neglected by the Boston Society of Civil Engineers is evident from the society's latest announcement, just received. Relative to an excursion to Salem on Oct. 20, the notice reads: "Everybody guaranteed to reach third base, but the committee cannot assist in getting home." What is termed a "smoker-sing dinner" was held that same evening at the Boston City Club, and was presided over by Charles H. Eglee. Another noteworthy announcement is that the Committee on Social Activities hopes to organize a strictly amateur (there should be no difficulty on this score) orchestra among the members, to furnish entertainment at the winter dinners. The committee requests any member who can play a musical instrument (from ocarina to harp) to communicate at once with Chairman Edmund M. Blake.

Appliances and Materials

Oakland Revolving-Bucket Scraper

A novel improved scraper has been developed from the fresno type by Child and Keir, of Oakland, Calif., and is being marketed by the Graves-Spears Road Machinery Co., of Oakland. The machine is shown in the accompanying view. It is claimed that a 6-ft. scraper of this type will move more dirt than two 5-ft. fresnos. Four sizes are made—with 5-, 6-, 7- and 8-ft. buckets.

A long steel bucket or bowl is pivoted in a stiff steel frame which is carried on shoes forward and wheels at the rear.

OAKLAND REVOLVING-BUCKET SCRAPER

The driver rides, loading and dumping with a foot lever. He does not have to pull the bucket back into place, as it revolves and locks when it comes into loading position. For grading it can be held at any angle desired. This scraper sells at from $75 to $200.

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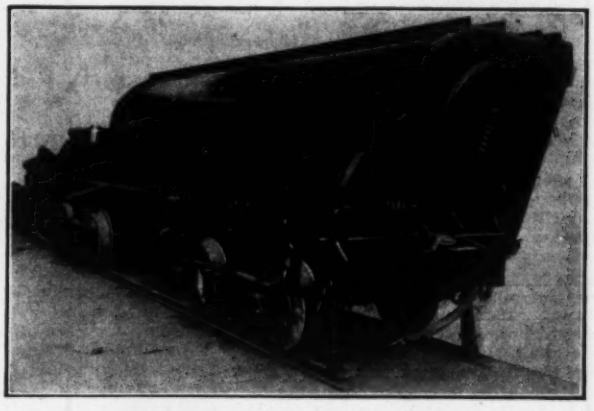
Round-Bottom Tilting-Body Dump Car

Tilting-body round-bottom dump cars have been frequently used around industrial plants and by a few contractors, but such equipment has been made in comparatively small sizes and for narrow-gage tracks (see "Engineering News," Apr. 8, 1915, p. 704). A similar car has now been developed by the Orenstein-Arthur Koppel Co., of Koppel, Penn., in large sizes for standard-gage lines and equipped with M. C. B. standard couplers, trucks, air brakes, etc. This is shown in the accompanying view. The particular car pictured was made for the Brittania Mining Co. of British Columbia, which desired ore carriers from which no leakage was possible. The frame



ROUND-BOTTOM TILTING-BODY ORE CAR

consists of a box-girder center sill with projecting buffer frames and body bolsters. The dumping body has a rocker at each end resting on a track supported by the buffer frame. The car tilts about a point just above the center of gravity when loaded. Small force is required to dump, and this is furnished by a crane which hooks under U-castings on the side. To prevent tilting in transit, chains run from the body corners to the buffer-frame ends.

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Smith Low-Level Hand-Charging Mixer

A new design of low-level hand-charging concrete mixer is being put on the market by the T. L. Smith Co., Milwaukee, Wis. Eight years ago the company had such a machine, but it was sidetracked by the demand for power-charging types. The recent increased demand for low-charging mixers has brought about the redesigning of the old machine. In general, a low platform takes the place of a gated batch hopper or a gear-driven charger. The platform is only 18 in. high, so that a barrow may be easily run up for emptying directly into the drum. The feed end is left almost entirely open and a narrow hopper is added to receive the upended wheelbarrow. To eliminate splashing, the drum width has been increased and a short wing has been added on the feed side of the blades. The scoop blades in the center of the drum are raised above the interior surface so there are no corners for lodging material. The machines are made in 3-, 4-, 6- and 9-cu.ft. sizes. All sizes are portable, being mounted on steel frames and trucks. The platform is hinged and folds up against the receiving hopper.

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Sewage-Spraying Nozzle

A patented design of sewage-spraying nozzle, shown in the accompanying view, is being marketed by the Snow & Petrelli Manufacturing Co., 152 Brewery St., New Haven, Conn. This is of the circular-orifice type which, it is reported, in service has demonstrated its ability to give an undivided spray and to minimize clogging. Inside the screw-cap is a 2-in. spherical chamber with a ½-in. to ⅝-in. orifice, above which is a trumpet-shaped deflector supported on a knife-edge bridge.

SNOW & PETRELLI NOZZLE

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Permanent-Green Paint

A new paint is being manufactured by the F. W. Devoe & C. T. Raynolds Co. under the name of "Mitis Green," which is claimed to produce a surface which will neither fade nor lose color, as is common with the green paints previously available. The paint is made in six shades of green and can be had in paste form, ground in linseed oil, or in liquid form ready for use.

Engineering News

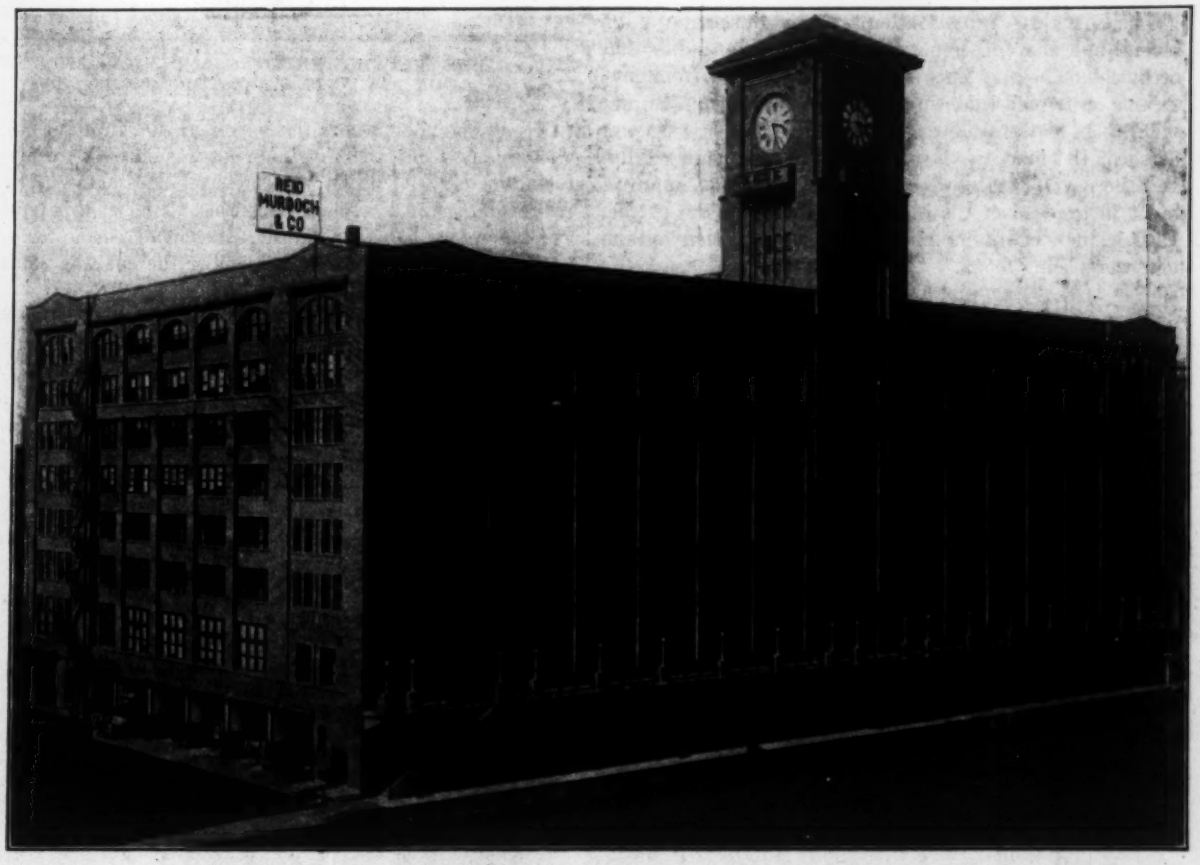
VOLUME 74 OCTOBER 28, 1915 NUMBER 18

River-Front Approach to a Chicago Building

The utilization of waterfront and the architectural treatment of buildings fronting upon the Chicago River have been discussed at various times in connection with city-planning movements at Chicago. An example of what may be accomplished in this direction is indicated by the new warehouse for the wholesale grocery firm of Reid, Murdoch & Co., at Clark St. and the river, as shown by the accompanying view. This building was designed by George C. Nimmons, architect, of Chicago.

The river front of the building has a special feature, a balcony or walk forming the approach to the office entrance. This balcony is a little above the level of the Clark St. sidewalk, at the north end of the bridge. At each end are steps leading down (from Clark St. at the east and from the balcony at the west end) to a concrete dock wall for the use of steamers and barges. At the wharf level are doors opening into the main basement and sub-basement, which are respectively above and below that level. The rear of the building has team space and a railway side track and is at the level of the end of La Salle St., which is at this low elevation on account of there being no bridge. Freight elevators descend below this level to the tunnels of the narrow-gage electric freight-railway system.

The balcony is a 6-ft. cantilever extension of the main floor of the building and consists of a 9-in. reinforced-concrete slab. It is designed for a live load of 150 lb. per sq.ft. An attractive appearance is afforded by the concrete lamp posts on concrete pedestals, between which is placed a light and ornamental handrailing with wire-panels. At each end of the balcony is a cantilever girder, the one at the east or Clark St. end supporting the approach platform and stairways. The wharf is 10 ft. wide.



CHICAGO RIVER WAREHOUSE WITH OFFICE ENTRANCE ON THE RIVER SIDE

The building has a river frontage of 322 ft. and is about 180 ft. deep, except that on Clark St. its frontage is only 42½ ft. The contractor was E. C. Scheidenhelm.

Building Low-Grade Line for Norfolk & Western R.R.

SYNOPSIS—Cut-and-fill work amounting to 2,800,000 yd., begun in May, to be finished by December. Shovel work in the cuts. Handling spoil to filling trestles. Slides—one fill still slipping; bad slides in a deep cut.

Fifteen steam shovels are working day and night on a low-grade single-track line of the Norfolk & Western Railway Co. in Virginia, between Burkeville and Pamplin, a distance of 37 mi. The new line will carry the eastbound freight, which is the heaviest traffic of the railway. Westbound traffic will continue to be sent over the existing single track. The location of the two lines with respect to each other is shown in Fig. 2. The location of the new line was started in January, 1915, and the first steam shovels were put to work on May 1. The grading should be completed in November, and it is expected that the track will be connected up complete before January, 1916.

The new line runs southeast from Burkeville until several miles beyond Meherrin, when the general direction becomes northeast. This is exactly the reverse from conditions on the old line, which runs northeast from Burkeville, then southwest toward Pamplin. The first 15 mi. or so of the new line is paralleled by the Southern Ry. and the next 13 mi. by the Virginian Ry. The improvement in grade over the old line is shown in the profile, Fig. 1, the maximum grade in either direction on the new work being 0.5%.

General Character of the Soil

Red clay is the predominating soil. It is everywhere the topsoil and extends usually below a depth of 20 ft. Sometimes it is underlain with a stratum of quicksand or a material closely resembling quicksand. At other times the substratum is soft, wet, slippery clay of greenish color, containing mica, which moves very easily.

There was very little excavation in rock, although there were a few cuts in which rock was encountered. In such cases it was drilled with well drills and blasted in quantity. At one point where the Virginian Ry. in a cut parallels the new line, the Virginian cut was entirely through rock that cropped out to the surface. Estimates of the cost of doing the Norfolk & Western cutting at this point were therefore based on the expectation of encountering rock. At the beginning of September the cut was 25 ft. deep and no rock had been struck.

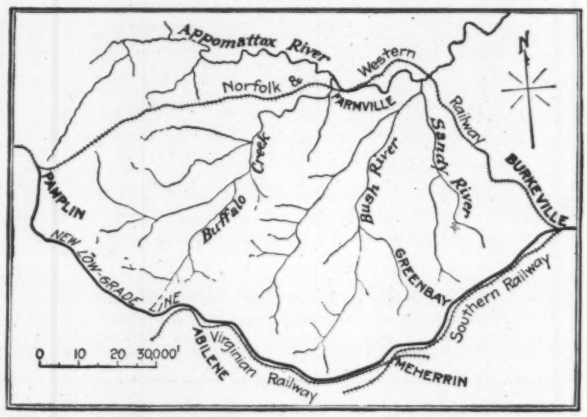


FIG. 2. MAP SHOWING EXISTING AND NEW LINES OF THE NORFOLK & WESTERN R.R.

The excavation totals 2,800,000 cu.yd. The work is divided into five contracts, which are supervised for the railway company by four resident engineers. Each residency embraces about 9 mi. of line. The engineer is assisted by a transitman, levelman, two rodmen and two

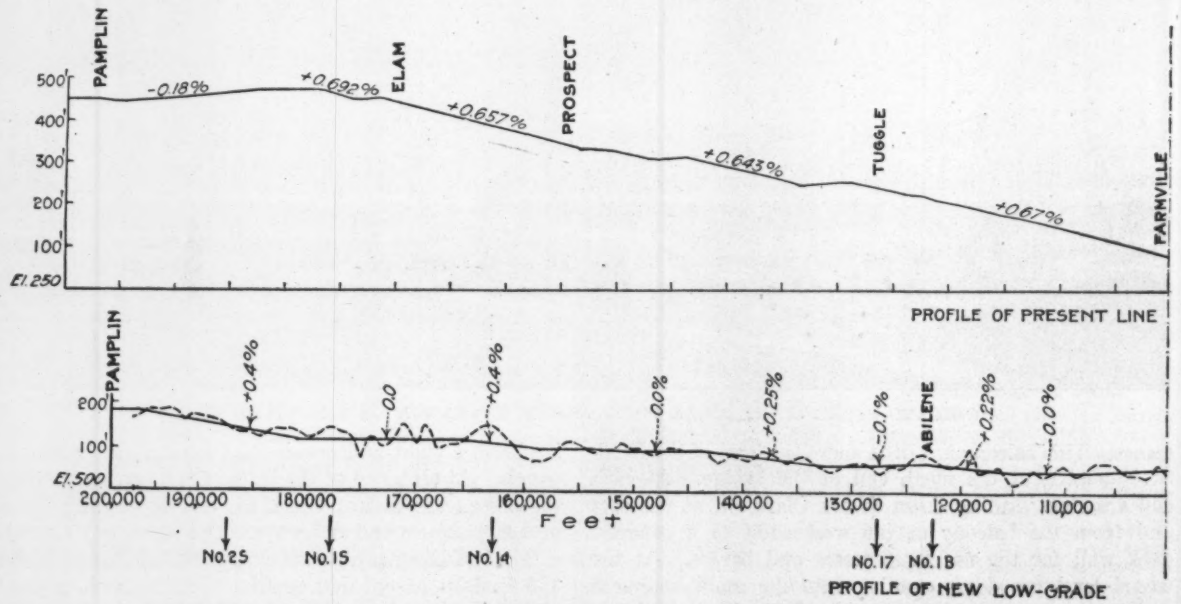


FIG. 1. COMPARISON OF EXISTING AND NEW LINES OF NORFOLK & WESTERN R.R. BETWEEN

chainmen. Each of these engineering subdivisions located its section of the line and has since been in charge of the construction work.

The steam shovels (dippers 2- and 2½-yd.) are distributed over the line as shown on the profile, Fig. 1. Patterson & Moran have the contract for section 1, which starts at Burkeville. The Robert Grace Contracting Co. has sections 2 and 3 (part sublet to Thomas J. Bennett). Rinehart & Dennis have section 4, and J. J. Sheahan has section 5.

Details of the Working Methods

Timber for temporary trestles for making fills is obtained either from the right-of-way (180 ft. wide) or is purchased from adjoining property owners. A steam shovel working in a near-by cut loads a dinkey train of 4- or 5-yd. Western side-dump cars, and the earth is hauled out on the trestle and dumped. Such a train consists usually of from 8 to 11 cars, but in one instance, where it was impossible to put a siding or turnout between shovel and trestle, 17 cars were hauled at one time.

The number of trips that a shovel must make through a heavy cut is indicated by the diagrams in Fig. 3, which are for an actual cut between Sta. 1705 and 1725 on section 5; J. J. Sheahan, contractor. Shovel cuts are 8 to 10 ft. deep. In its first trip the shovel loads into dump cars running on a track laid on the original surface. When this cut is completed the shovel starts the second cut alongside and below the first, loading onto a track in the first cut. When the shovel has finished a trip it is returned to the other end to start forward again, the cutting progressing uphill to provide drainage for the cut. Fig. 4 shows methods of excavating 30-ft. and 40-ft. cuts.

Lack of room in the cut made it necessary to place the siding outside at the entrance, which in the case of long cuts caused an unfortunate but unavoidable delay between the loadings. If a shovel were operating 2,500 ft. in from the entrance and from the siding of a certain cut, a train would have to pull in to the shovel, be loaded and pull out over the half-mile of track before the next train of empties could start for the shovel. This particular delay is represented by the time required to run 7,500 ft. on the construction track, plus the time of actual loading of one train, and at 10 mi. per hr. would amount to about 8 min. for the running time alone. In the meantime the shovel could loosen up some of the bench ahead of it, but for at least two-thirds of the period between trains it would be idle.

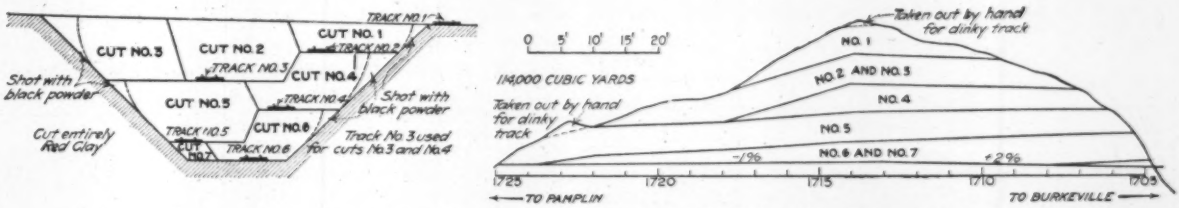


FIG. 3. NUMBER OF TRIPS OF STEAM SHOVEL IN A 45-FT. CUT

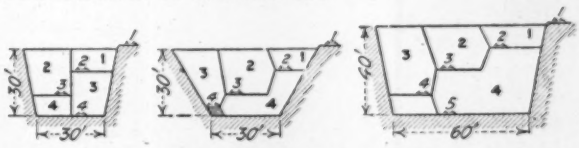
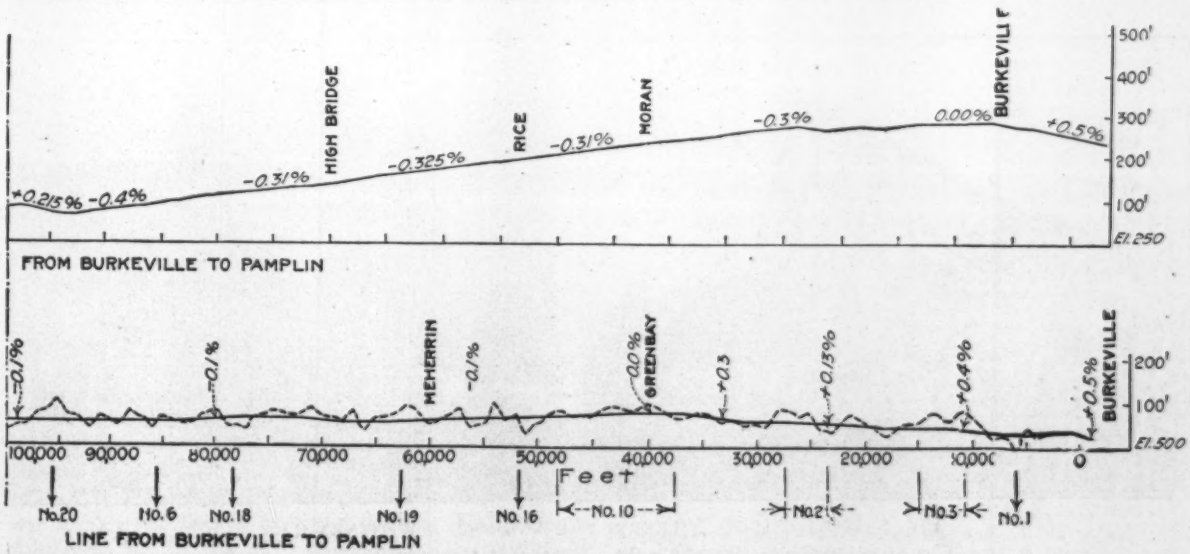


FIG. 4. CROSS-SECTIONS OF 30-FT. AND 40-FT. CUTS, SHOWING SUCCESSIVE LOCATIONS OF SHOVEL

The usual scheme was to employ as the first siding a portion of the first construction track, which, as previously stated, had been laid on the surface and used for loading purposes (Fig. 7), while the shovel was making its first trip through the hill.

After the shovel had completed its work and had moved on to the next cut, trimming of the side slopes commenced. The sides were trimmed by hand to the desired



BURKEVILLE AND PAMPLIN, VA., SHOWING SHOVEL LOCATIONS (BY CONTRACTOR'S NUMBER)

slope, ranging from 1:1 to nearly vertical. The tendency was toward steep slopes, as they are the most economical from the construction standpoint. They are dug

TABLE 1. STEAM-SHOVEL EXCAVATION

Month and Week	No. 19	No. 16	No. 18	No. 6	No. 20
May 8	7,000	.....	.....	.....	.....
15	7,000	.....	.....	3,200	.....
22	5,200	.....	7,900	5,600	.....
30	6,500	.....	9,400	1,600	.....
May total	25,700		17,300	10,400	
June total	43,200		49,500	25,600	44,300
July 8	12,000	300	12,000	3,800	7,200
15	11,200	7,100	11,400	6,500	8,200
22	5,300	7,100	7,900	7,800	14,800
30	11,600	15,800	18,500	6,300	12,700
July total	40,100	30,300	49,800	24,400	42,900
Aug. 9	5,800	9,600	10,300	5,500	10,700
16	9,230	10,700	12,500	5,700	10,200
22	7,500	12,300	12,900	3,600	12,000

nearly vertical by the shovel, and the top is rounded over to reduce slides. The width of cut or fill is determined by the formula 24 ft. plus $\frac{D}{5}$, where D is depth.

There were five gangs at each cut-and-fill—shovel gang, trestle gang, pit gang, track gang and dump gang. There were 366 men at work on the first residency, 700 on the second, about 200 on the third and 170 on the fourth. The rate of excavation is well shown by Table 1, covering the shovel work on the second residency (Robert Grace Contracting Co.)

Sometimes deep fills were made in two lifts by first building and filling a low trestle and then erecting a trestle on top of this and filling from this second trestle. Where there were concrete culverts such procedure would prevent the heavy impact upon them which would result from high dumping.

Sliding of a Fill and of a Cut

Only two slides of importance had occurred up to Sept. 1. One was in a deep wet cut and was caused by the movement of quicksand. The other was on a high fill and was caused by the slippery clay already mentioned.

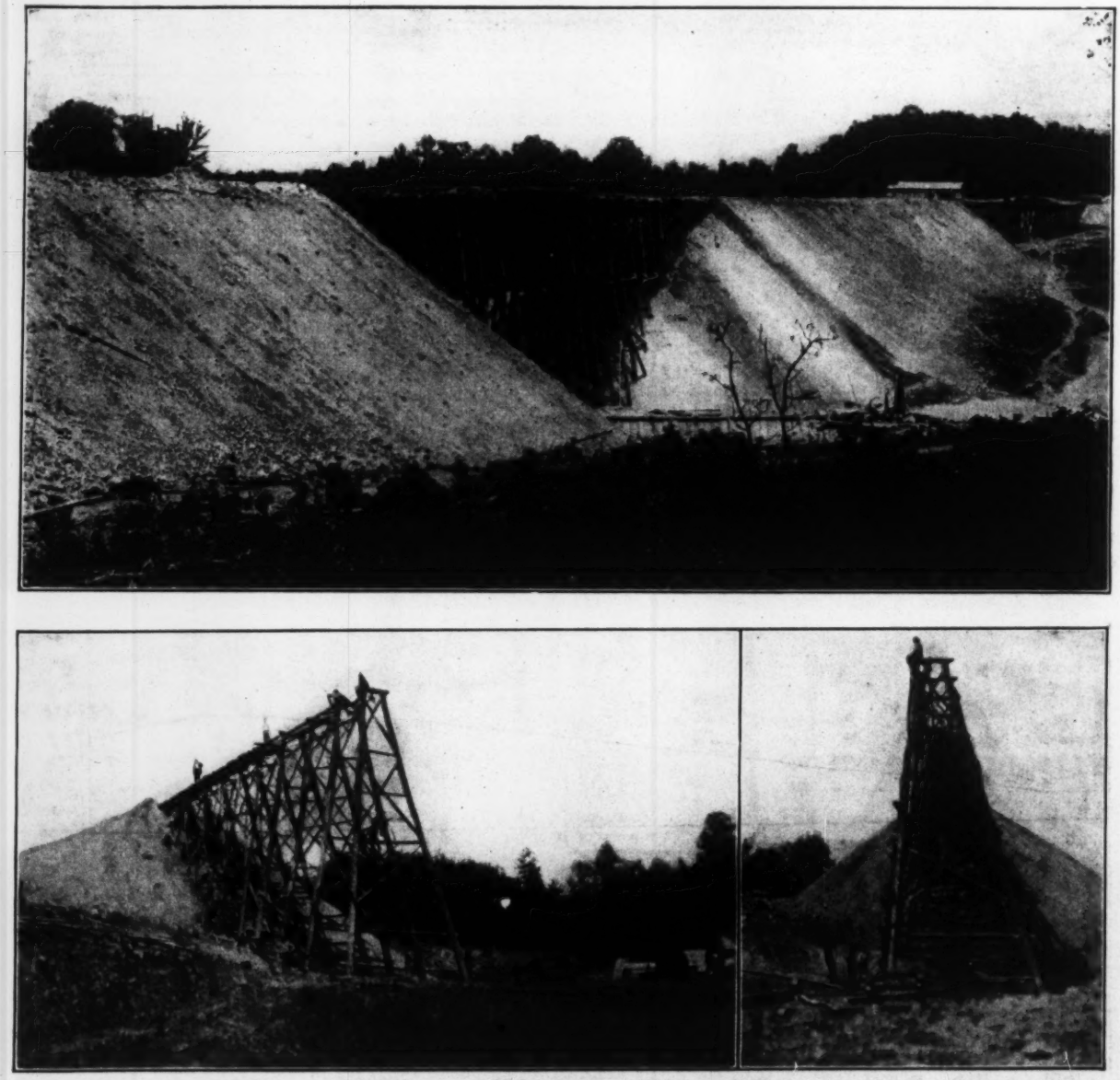


FIG. 5. MAKING 55-FT. FILLS ON THE NORFOLK & WESTERN R.R.
Upper—At Burkeville, Va. Lower—At Meherrin, Va.

The deepest fill on the Burkeville section was left open in the center temporarily to allow a concrete culvert to set (see upper view in Fig. 5). Two weeks were required for setting, and during this time the filling proceeded on each side. The culvert was 243 ft. long, 8x8 ft. in cross-section, crossing on a skew. The open part of the fill

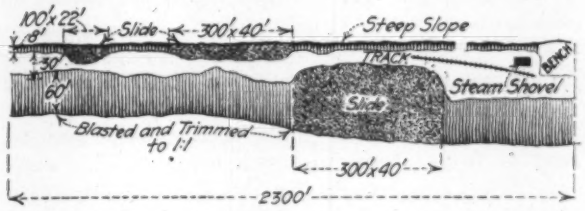


FIG. 6. PLAN OF WET CUT, SHOWING NARROWING DUE TO SLIDES

(and trestle) was 200 ft. long and 55 ft. high. Wet mica clay had been struck in the cut ahead. This was hauled to the trestle and dumped after the concrete had sufficiently set. When the fill had been brought to the top of the trestle it slipped, pushing out the toe on each side, and settled 20 ft. This occurred first on Aug. 1 and was repeated time after time. A certain amount of clay would be dumped onto the fill without its movement; but when more was added longitudinal cracks would occur and the whole would slump.

The first part of the material of this fill had been very wet; by the time a heaped-up carload could be transported to the fill the clay would be level with the side of the car. Later, the earth was taken out of the cut in a drier state and dumped on the fill, but the wet, slimy material formed the core and base and the sliding continued all through the month. One of the slips pushed out the trestle for more than a foot on each side. Some of the slips occurred on the concrete culvert the strength of which was thoroughly tested in consequence.

Bedrock at the site of this fill was only 4 ft. below the surface. To stop the slide it was decided to form an apron

FIG. 7. SIDING FOR DINKEY TRAINS, USING FIRST LOADING TRACK LAID ON HILL

of hard-packed red clay and to build up the fill on a gradual slope, 1¾ : 1 to 2 : 1. The red clay was carted in wagons to both sides of the foot of the trestle, where it was leveled and packed by mules drawing drag-scrapers. Movement of fill has not ceased yet. The contractors are still trying to stop it by teams dragging out the toe, and by making benches out of the material 5 ft. high with a 2¼ : 1 slope.

A series of slides occurred in a wet cut located between Sta. 1606 and 1631. At one point in the cut there was a vertical face 40 ft. high. Evidently slices of the bank had slid forward a distance of 20 ft., probably on a stratum of quicksand at the foot, and collapsed. Where sliding was excessive the slopes were shot to 1 : 1. Elsewhere in this cut the sides were nearly vertical. Fig. 6 is a plan of the unstable portion of this cut and shows narrowing due to slides.

Wet cuts were drained permanently by laying a line of 10-in. drain tile in a trench. This was covered with straw and then with earth. The berm ditches were 2 ft. wide, 1 ft. deep, and placed 15 ft. from edge of cut.

The work is under the supervision of J. E. Crawford, Chief Engineer of the railway; A. Bruner, Assistant Engineer. The following are the Resident Engineers from Burkeville toward Pamplin: White; Derrick; Hughes; Johnson.

Municipal Swimming Pool

An open-air municipal swimming pool is a feature of interest at Grand Rapids, Wis. It is on ground sloping from a main road to the river, just below the water-power dam, and is fed by a continually running stream of water from the river above the dam. Concrete walls were built to form the pool and the bottom is covered with sand. It varies in depth from 1 ft. at the upper end to 6 ft. at the lower end.

A large sluice gate at the lower end provides for emptying the pool, and is arranged for quick operation in case of an accident. The gate can be dropped by gravity, and anybody can operate the mechanism which frees the gate so that it will drop from the pressure of the water in the pond. It was realized that diving for a person drowning would be better than waiting for the water to be emptied from the pool, provided there was always someone on hand to do the diving. But when the pool was built there was no very definite idea as to how it would be taken care of, and no great amount of money has been provided for an attendant. Therefore it was planned to make it as near danger-proof as possible.

The entire pool can be emptied in about two minutes, but of course in a fraction of that time the depth would be reduced sufficiently to permit of wading, while the shallower part would be uncovered in a few seconds after the gate was opened.

The ground was donated by the Consolidated Water Power and Paper Co., which controls the river front rights at this point. The expense of construction was met by popular subscription and a donation from the city. The total cost has been about $5,000. The work was designed and built under the direction of L. A. De Guere, architect and engineer, of Grand Rapids, Wis.

Peru's Demand for Machinery Fell off in 1914, because most of the principal undertakings, such as hydroelectric developments, begun in 1912, were finished in the latter part of 1913. Consul-General William W. Handley, Callao-Lima, states that American machinery of all kinds is popular in Peru and that the sales exceed those of any other country. The imports from the United States in 1913 were valued at $918,933; the figure for 1914 was only $487,121. The total value of imports of machinery from all countries during 1914 was $865,268, as against $1,475,566 in 1913.

Penstock Carries 5,412-Ft. Head

The difficulties connected with the penstock design for the Lake Fully hydro-electric station, Canton Valais, Switzerland, were considered by some engineers very nearly insuperable; but M. Boucher, of Lausanne, the designer of the two plants of next highest head (Vouvry in the same canton and Orlu in the Pyrenees, with heads of 3,116 ft.) was highly successful here and the plant was placed in operation a few months ago. The selection of material, the types of joints and the location of the pipe were the important factors. These were described by S. Larsen, who visited the plant for the Norwegian Government, in a lecture before the Polytechnic Society at Christiania. The translation has been furnished by A. G. Hillberg, Hydraulic Engineer, New York City.

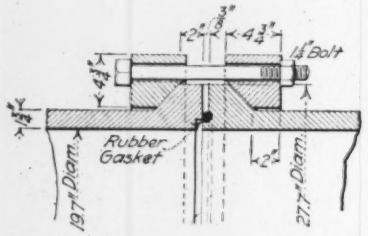


FIG. 1. DETAIL OF FULLY STRAIGHT PENSTOCK JOINT

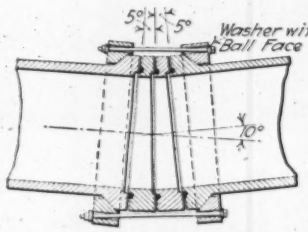


FIG. 2. PENSTOCK JOINTS AT POINTS OF DEFLECTION

The conditions under which the penstock was designed were as follows:

Static head	5,412 ft.
Operating head	5,248 ft.
Average discharge	6.36 sec.-ft.
Maximum permissible velocity	13.12 ft. per sec.
Length of penstock	2.8 mi.

At Lake Fully a dam was built raising the water level about 23 ft. This was done in order to create a sufficient pondage and to economize on the available water supply. From the lake the penstock descends into the Rhône Valley, where the power house is located. The inside diameter of the pipe is 23.6 in. in the upper part and 19.7 in. below. The wall thickness varies from ¼ to 1¾ in. The study of various kinds of pipe resulted in the selection of welded pipes for the upper portion and seamless drawn pipes for the lower sections. In order to keep the weight of each section of pipe as near as possible to 4 tons, the lengths were varied in 3-ft. steps from 20 to 40 ft. At the power house, where the pressure is heaviest, there are 56 pieces, each 20 ft. in length, with a wall thickness of 1¾ in. These pipes were tested at the shops under a hydraulic pressure head of 8,200 ft.

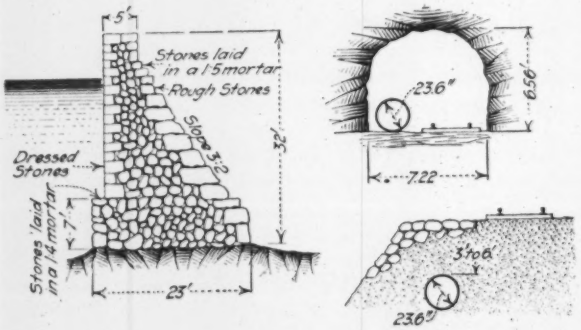


FIG. 3. LAKE FULLY DAM AND PENSTOCK LOCATIONS

The accompanying sketches show the main details of this penstock. Each end of a pipe section is provided with special conical flanges, over which fits a set of chamfered rings held together by bolts. In order to get these rings around the pipes it was necessary to split them in halves and to bolt the sections together. Tightness has been insured by a rubber gasket ring of circular cross-section.

At points where the pipe line was deflected, either in the horizontal or vertical plane or in both simultaneously, the angle was joined by the insertion at the joints of rings with inclined faces, as shown in Fig. 2. The angle between the faces of one of these rings is 5 deg. By using two rings and rotating them in respect to each other, any angle from 0 to 10 deg. was obtained. By using several rings any desired angle within reason could be joined.

In order to avoid supporting piers, anchorages and expansion joints and to insure the continuity of service against freezing and avalanches, the pipe line has been buried in the ground. To obtain a good alignment it was found necessary at several places to lay the pipe in tunnels.

The maximum unit stress in the walls of the penstock is about 13,300 lb. per sq.in.

Care had to be taken to prevent water hammer in this pipe. The Pelton wheels were therefore equipped with automatically operating, double-acting, oil-pressure governors—Piccard-Pictet system. This governor has a movable deflector in front of the nozzle, so that the jet can be quickly cut off from the wheel. The needle is then slowly moved, and when the jet has been regulated to suit the new load requirement the deflector is withdrawn. (See *Engineering News*, Jan. 21, 1915, p. 139.)

The penstock was manufactured by Thyssen & Co., of Mühlheim, Germany. The owner of the plant is the Société d'Electro-Chimie, of Martigny, Switzerland.

What Is the Trouble with Our Engineering Education?*

By Edward Orton, Jr.†

A new expenditure of unprecedented magnitude is being inaugurated here today to provide opportunities for the study of the problems of the clay and allied industries and for the training of young men to enter these industries on a professional or engineering basis. The ceramic school of university grade is a distinctly American institution. The change in the educational ideas disclosed between ceramic training of twenty-five years ago and that being given here and elsewhere in America today is a startling one. And now, at the beginning of still greater and more ambitious preparations, it seems wise and appropriate to cross-examine ourselves and make sure that we are on the right track and that we can give a reason for the faith that is in us.

*From an address delivered at the laying of the cornerstone of the Ceramic Engineering Building, University of Illinois, Sept. 27, 1915.

†Dean, College of Engineering, Ohio State University, Columbus.

Among the friends of technical education there are some, perhaps many, possibly even a majority, who think they perceive in the present increasing subdivision of technical education, in the growing number of courses, with the implied narrowing of the field occupied by any one course, a real and serious danger. The complaint of the users of engineering graduates is most commonly directed to their lack of grasp and power to use their fundamentals—their mechanics, their physics, their mathematics, their English. They say that the young engineer has been over so many subjects that he hasn't had time to go through any. We are accused of forgetting that the capacity of any group of healthy, vigorous young men to absorb knowledge and to acquire power to use knowledge in novel fields is about the same from year to year. To borrow a homely illustration from the kitchen, our technical professors are accused of trying to can more fruit than their cans will hold.

Less Pretentious Schedule Demanded

Not a few eminent engineers and large employers of engineering labor have urged the technical schools to give over trying to do the impossible and to return to the simpler, less differentiated courses, with more time on each subject and more practice in the application of each subject taught. They take the ground that in the nature of the case the industries themselves must act as the final schools for the young engineers who are being brought in for the maintenance and extension of these industries. These appeals from the industry have, if anything, grown in volume and insistence in the last decade. But the technical schools have, so far as I can discern, not yielded much if anything to them. In my judgment the discussion of this educational policy must continue and increase until it brings action. I think technical schools must settle down to a much better defined and less pretentious schedule. The four-year technical course of the future will, in my opinion, prepare young men to enter their profession as beginners, with the very clear understanding that expert knowledge of any field must come through the specialized schools maintained in and by the various industries themselves or through the graduate research and experiment stations at the universities or through both.

The bearing of this discussion of engineering or technical education on the case in hand here today may not at first be clear. We are gathered together to lay the cornerstone of a new structure whose purpose is to teach one of these very subdivisions of knowledge which has been described and in a way frowned upon. Is it justifiable educationally and industrially to make such splendid provision to carry out a plan whose foundation principles are still under debate? In answer to this I say that we must distinguish between subdividing a field of knowledge and cramming a course of instruction.

Subdivision of the field of knowledge in technical schools is not, *per se*, a danger or a weakness. It becomes a weakness whenever the training becomes superficial—whenever the mass of detail is allowed to obscure or replace the foundation. In fact, subdivision of our courses of study is not only not inconsistent with sound educational processes, but may be regarded as a step toward strengthening them. The subdivision of civil engineering, for instance, into railroad engineering, sanitary engineering, municipal engineering, structural engineering, hydraulic or irrigation engineering, to a large extent relieves the tendency to try to crowd a little of each of these subjects into one undivided or unspecialized civil-engineering course.

On the other hand, subdivision in itself is no safeguard against cramming; the temptation to cram is still there and must be resisted alike by school authorities, students and the industries. The views of undergraduates are almost always crude and materialistic in such matters, and they nearly always tend to overestimate the importance of special knowledge over general principles.

The thing which made the old course of two generations ago strong was the thoroughness of the drill in the foundation subjects. With a curriculum meagerly representing engineering, these early schools produced engineers who became famous. Why? Because they hammered their physics and mathematics and English in until the student could use them.

It is no longer possible or desirable for our schools to try to obtain the results of two or three generations ago by return to the methods of that time. The old-fashioned all-round scholar, who was a cultured gentleman first and always, and who knew something in every field, was the product of a social system which has gone. But the principles which made the education of that day sound and productive and fertile are still the same! All that is necessary is to preserve the principle of thoroughness in all that is done—to direct the educational process toward producing power to think.

Specialization Still Necessary

Any good engineering course must, in the nature of the case, contain the same foundation. The foundation subjects, developed as far as is needed for securing the working power previously described, will require from 50 to 60% of the time of the engineering student in his four years. In the first year they take practically all of his time. As he goes further, descriptive and specialized courses founded upon or utilizing the foundation courses come in, together with some few of a more general cultural value. Toward the last these specialized courses may comprise a large part of the work.

The acquirement of the power of constructive thought, which is the object of all technical education, can be had through one set of descriptive subjects as well as through another. I hold that it is immaterial whether the illustrative matter in a course of education is chosen from civil engineering or mechanical engineering or chemical engineering. I hold that it matters not whether it be ceramic engineering or electro-chemistry or aëronautics.

It is perfectly true, therefore, that in our modern specialized and subdivided technical education we may be weakening our product and discrediting the engineering profession or we may be creating strong virile thinkers and apt workers who will be the leaders in their field, according as we disobey old and tried principles or obey them. A specialized education is not *per se* either a good one or a bad one; it is not necessarily either strong or weak. It is as easy to train the human mind using illustrations and problems from one industrial field or scientific field as from another. The whole value of the process and the strength of the character produced will depend not upon the technical content of a course of instruction, but upon the thoroughness with which the foundation is laid and the persistence with which the principles are applied as the work progresses.

Portland Harbor Bridge

SYNOPSIS—A million-dollar bridge connecting Portland, Me., with South Portland across an arm of the harbor. Distinguished by great variety of design, embracing reinforced-concrete girder and cantilever spans and steel cantilever girders with rolling-lift drawspan.

A highway bridge, remarkable not only for its magnitude, but for the variety and originality of its design, is now in course of construction across an arm of Portland Harbor between the cities of Portland and South Portland, in Cumberland County, Me. The bridge takes the place of an old timber structure on approximately the same site and is being built by the County of Cumberland with some assessments on the street-railway company which crosses it and a terminal company over whose yard it passes.

The main section of the bridge, as shown in Fig. 1, extends from the foot of Brackett St. in Portland across the deep cut of the Boston & Maine R.R., Commercial St., the tracks of the Portland Terminal Co. and the harbor (which has at this point a maximum depth at low water of 35 ft. and a tide range of about 13 ft.), reaching South Portland on the line of Ocean St. At the Portland end there are three approaches; the one from Brackett St. descending a steep grade on an existing street to the bridge proper and involving no structural work except at the abutment of the bridge. To the northeast the approach is from a sidehill viaduct to the line of State St., and down this approach the main street-car entrance to the bridge will be made, improving materially the present roundabout entrance to the existing bridge. To the southwest a rather steep approach takes the bridge on the line of Clark St. to the low-level street, through which all of the heavy shore-line vehicular traffic will probably pass. The State St. and the Clark St. approaches are both separate structures, as shown in the so-called "southerly elevation" in Fig. 1.

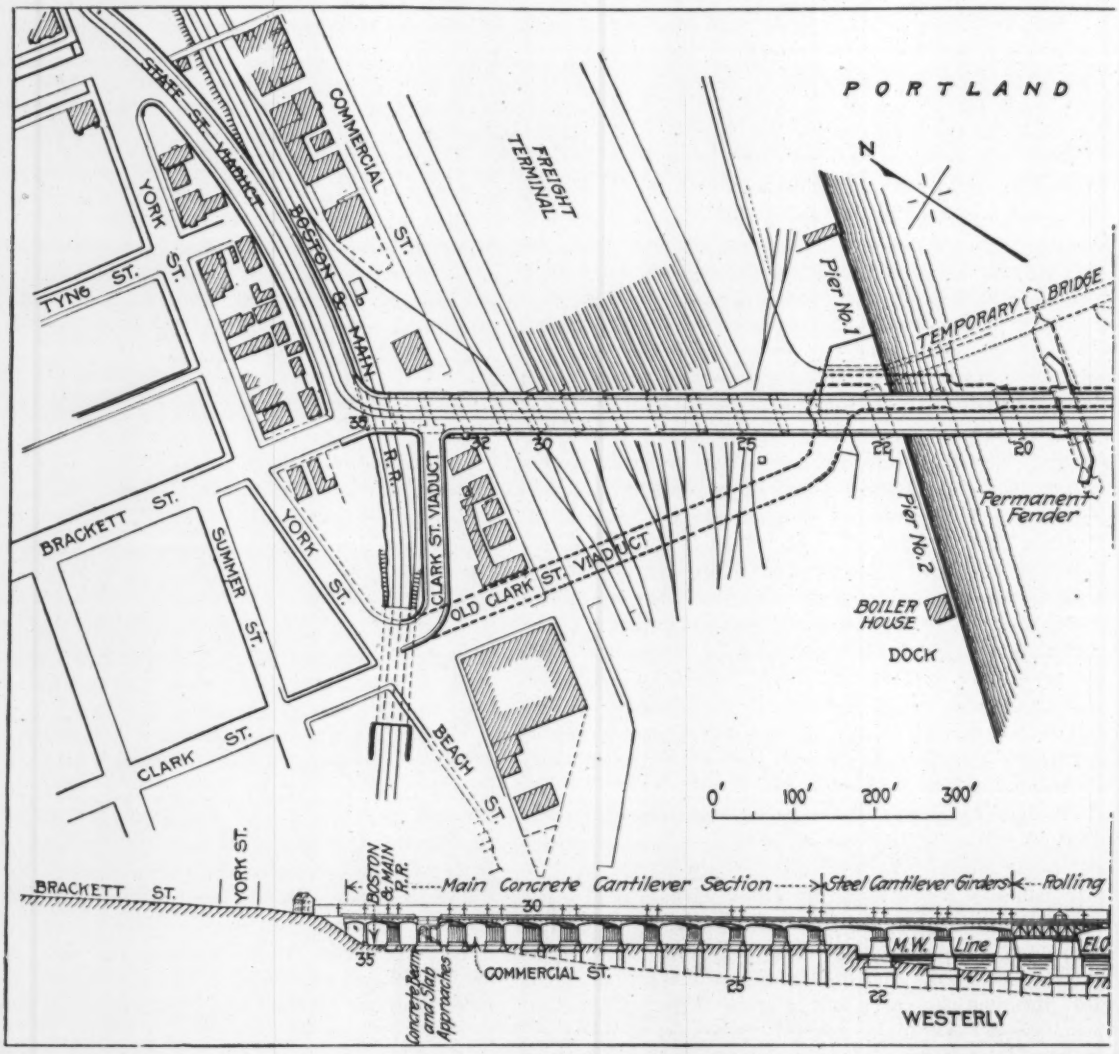


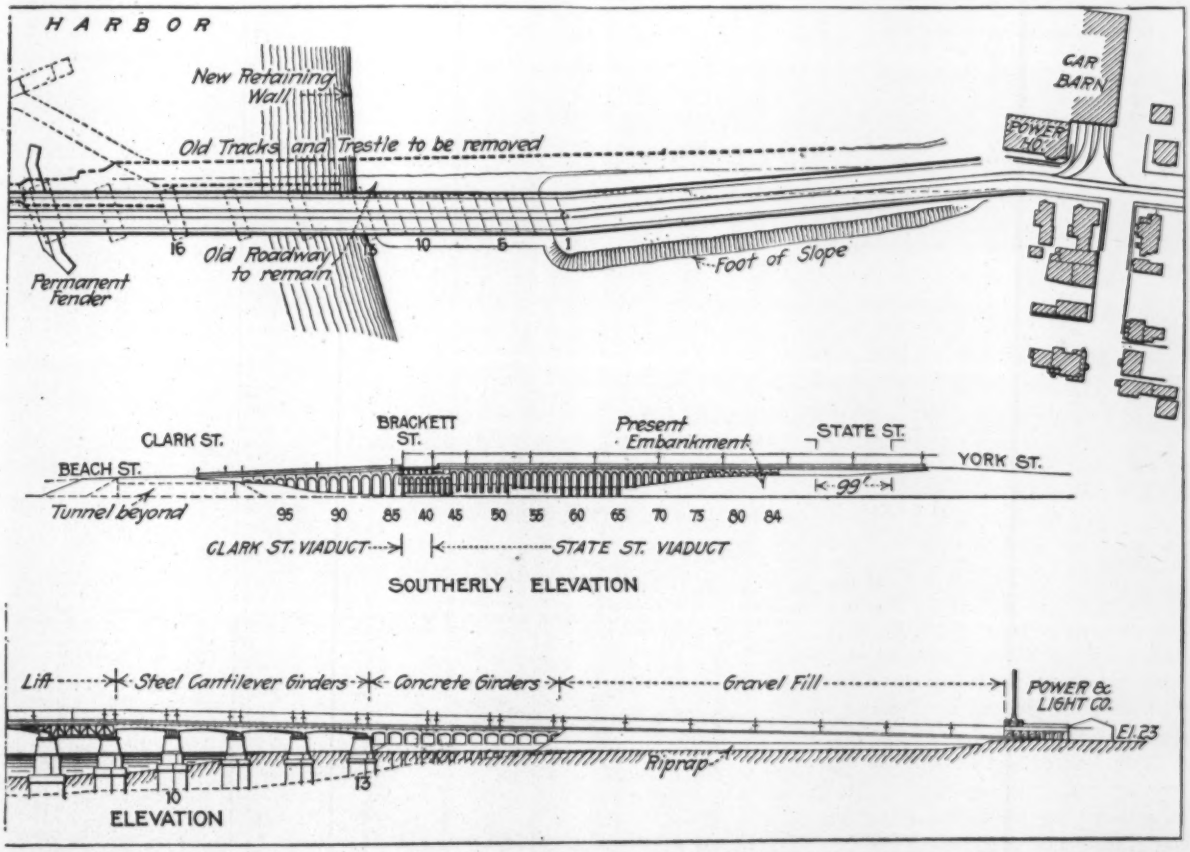
FIG. 1. PLAN AND ELEVATION OF BRIDGE NOW UNDER CONSTRUCTION

The structures for the various parts of the bridge are so radically different in design and in material that they will have to be described separately.

Beginning from the Portland end of the bridge, the State St. approach is a viaduct built upon the slope north of the railroad track from Brackett St. to State, a distance of about 700 ft., a small part of the street being cut into the slope and the rest supported on reinforced-concrete beams and piers. This section is made up of tall thin beams carrying a reinforced-concrete floor system, the piers being joined together on the showing face with arches so as to give an architectural impression similar to the old Roman-viaduct type. A view of this completed structure is given in Fig. 4-A. The southerly approach is a reinforced-concrete viaduct extending westerly from near the northerly end of the State St. viaduct to the junction of Clark and York St., a distance of about 320 ft. This section, while resembling in its facia appearance the State St. viaduct, is in reality a reinforced-concrete floor carried on tall slender reinforced-concrete columns joined together in both directions with arched beams. From the juncture of these two approaches (see Fig. 4-B)—that is, from the north approach of the bridge—to the northerly water edge of the harbor the a rolling-lift drawspan. The piers are of rectangular plan and with a section decreasing as the pier rises. They are of concrete, faced with cut granite as a protection against wear in the intertidal space, and are founded on wooden piles. The steel spans are on piers of a uniform skew and have a uniform c. to c. pier distance of 98 ft. The cantilever overhang is uniformly 16 ft. 4 in.

From the south bank of the harbor a distance of about 275 ft., the structure is made up of a fill portion on the westerly side of the existing roadway up to an elevation 12 ft. above mean low water, and a superstructure consisting of a reinforced-concrete viaduct of the short arched-beam type supported on concrete piers and foundations resting on wooden piles. From this point south a distance of 875 ft., the southern approach is an earth fill partly over the old-filled southerly approach to the old bridge.

The total length of the main bridge is about 3,000 ft.; its width is 60 ft., and it carries a double-track interurban railway system, with a roadway and a sidewalk on each side. Work on the structure was started about a year ago,



ACROSS PORTLAND HARBOR, BETWEEN PORTLAND AND SOUTH PORTLAND

structure consists of a reinforced-concrete viaduct about 700 ft. in length, which is made up of a series of reinforced-concrete cantilever beams carrying a reinforced-concrete floor and resting on concrete piers of the column-bent type.

Over the harbor the structure is composed of steel cantilever girders with a central section comprising a Scherzer rolling-lift bridge with two truss approach spans of steel. The total length of this section is about 1,009 ft., with 10 piers, 7 steel plate-girder spans, 2 steel truss spans and and its completion is expected some time during the coming summer. In spite of the general appearance of the bridge, there is not an arch structure in it.

The State St. viaduct approach parallels a deep cut of the Boston & Maine R.R. made many years ago. This cut was in a rock formation which was left with rather a steep bank on the upper face, protected at its bottom with a cut-stone wall. In the original design of the new bridge it was supposed that this stone wall was of sufficient stability to permit its being used as a base for columns or wall

of the viaduct, but in construction it was found that the old stonework was so dilapidated that it had to be torn out and rebuilt at the places where it was used as a footing.

The drawings in Fig. 2 show the details of this structure. As will be seen there, it consists of cross-walls 12 in. thick spaced 12 ft. 3 in. c. to c. carrying a reinforced-concrete floor slab for roadway and a bracketed slab for the outside sidewalk. The inside sidewalk is formed on the natural slope of the hill. This cross-wall is not in reality a continuously supported wall, but is rather a very deep transverse beam carried near its inside end on a stepped pedestal with a short cantilever extending up the side hill, and on its outside end by a deeper pedestal which foots for the most part of the section on the old retaining wall. The outside face of the structure is formed in facia arches for architectural effect.

The expansion is cared for in this section by breaking the flooring, and the facia arches at every other bay, as is also shown. An interesting detail is the dropping of the floor slabs to allow the railway ties to be set directly on the slab except for the 1-in. sand cushion.

The Clark St. approach, which is on a 3.3% grade, carries only the highway and sidewalk. It is of the usual column viaduct type, details of which are shown in Fig. 3. It has no particular distinguishing feature, except perhaps the height of the highest columns, which reach to 25 ft. of unbraced length in one direction, in which case the center line of columns is of 22-in. square section and the outer lines are 22 in. square with a 12x12-in. pilaster on each transverse face; curved cross-beams are used for architectural effect.

The roadway scuppers might also be noticed. Inasmuch as the ground underneath this approach is not in use, it was feasible to lead the surface drainage to scuppers that discharge directly under the bridge.

The main northerly section of the bridge is shown in Figs. 5 and 6. This comprises 13 piers resting variously on hardpan and on wooden piles, depending on the nature of the ground, and carrying a reinforced-concrete structure made up of longitudinal beams with a reinforced-concrete floor. Owing to the irregularity of the railroad tracks in the terminal yard over which this section passes, both the piers and the cross-beams are decidedly irregular in their angle of skew, a fact which increased measurably the difficulty of form work.

The piers consist of prismatic bases carrying reinforced-concrete columns with a transverse integral cross-beam arched between the columns. The longitudinal girders are in effect cantilevers, each main span extending outward a distance of 12 to 15 ft., varying with the location, and carrying an intermediate suspended span. The curving of the bottom line of the longitudinal girders is such as to indicate from a distance that there exists a series of curved beams of continuous construction or else of independent structure. In construction the main spans, with their overhang, were built first and the suspended spans cast on the overhang after the constructed work had taken a set.

The piers for these girders are on a variable skew so that the girder lengths vary in each span. The longest

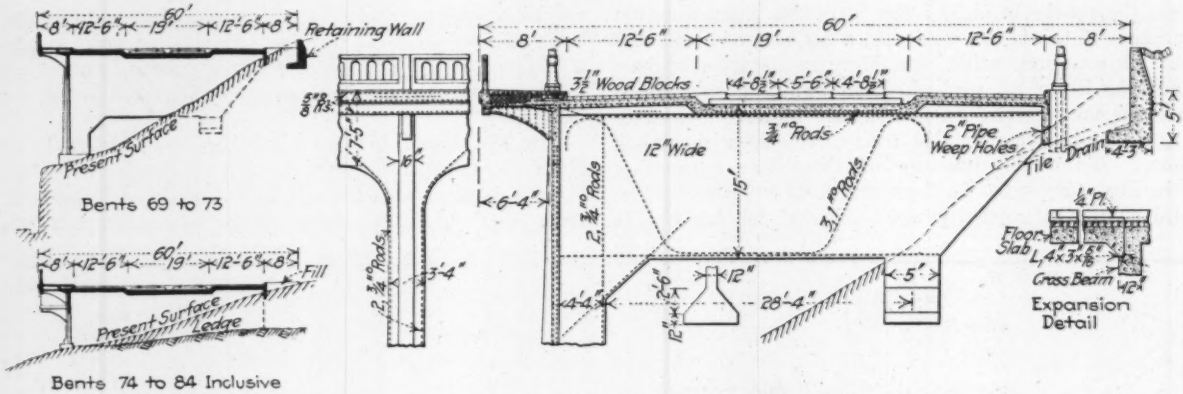


FIG. 2. NORTH, OR STATE ST., APPROACH TO PORTLAND BRIDGE

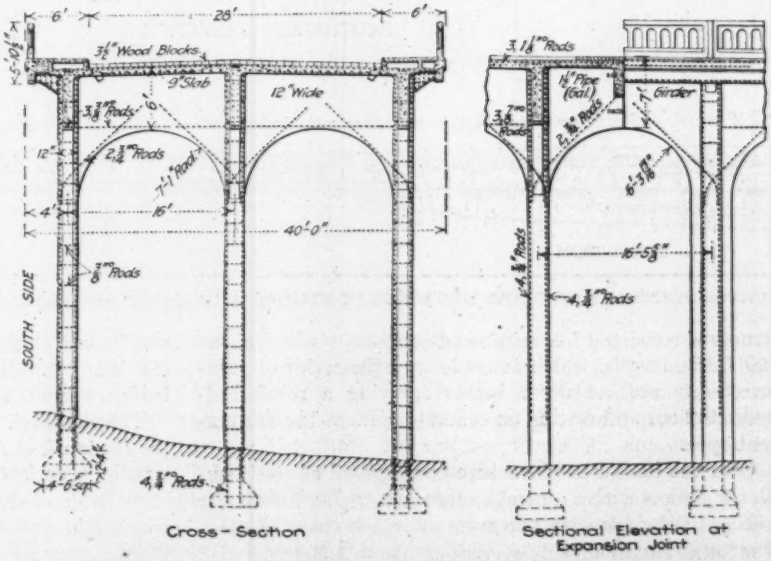


FIG. 3. DETAILS OF CLARK ST. APPROACH, PORTLAND BRIDGE

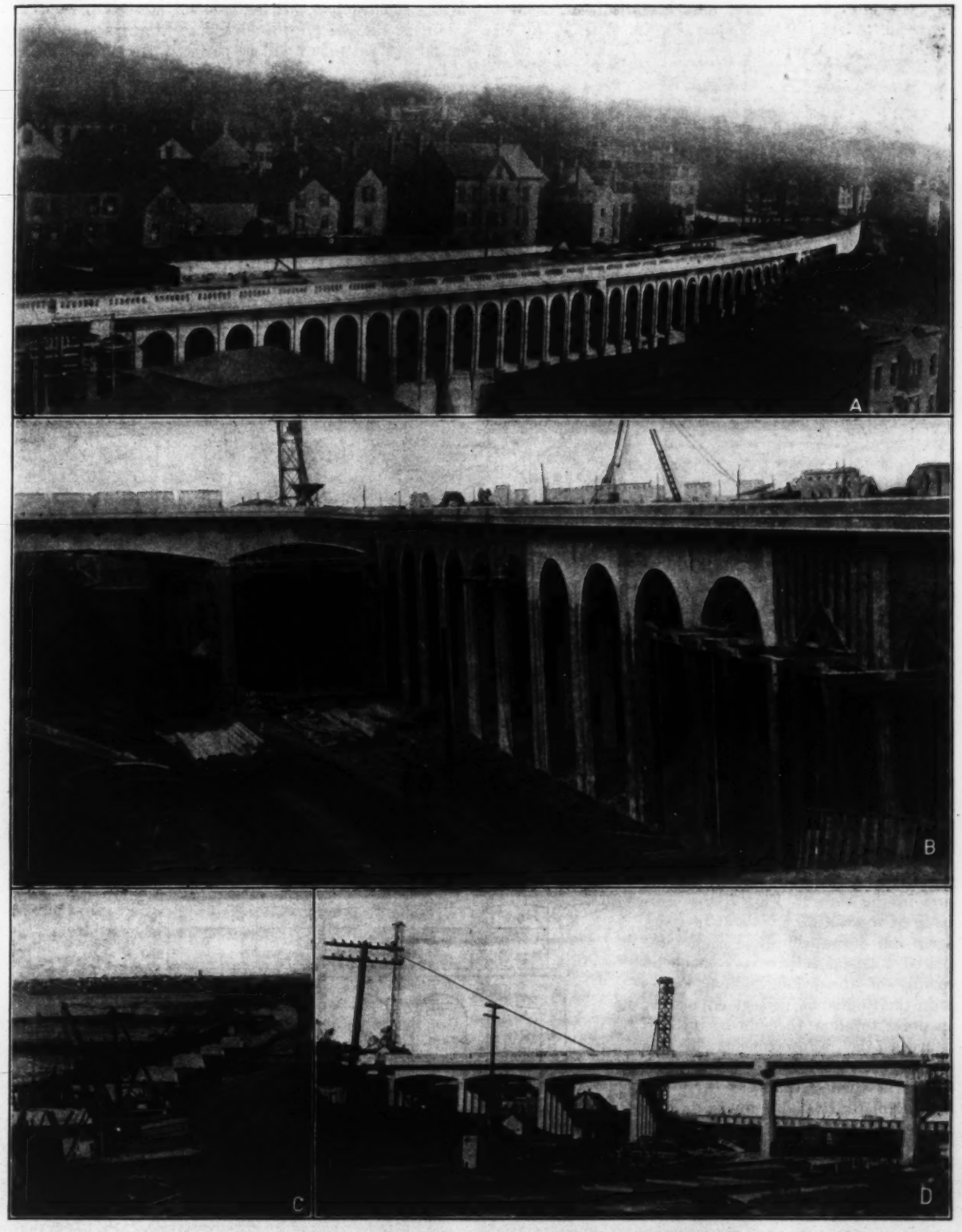


FIG. 4. VIEWS OF PORTLAND BRIDGE UNDER CONSTRUCTION

A—The completed State St. approach. B—Looking north toward the juncture of south approach and main north section of bridge; approach on left, bridge on right. C—Looking toward South Portland over the steel spans; approach fill in background. D—Completed cantilever spans of main northerly section of bridge

spans, however, have the following dimensions: Span 27-28 (main span) is made up of a central section varying from 57 ft. $3\frac{1}{16}$ in. on one side to 58 ft. $\frac{7}{16}$ in. on the other, with overhanging sections of about 12 ft. 6 in. each. Span 28-29 (suspended span) has a total opening of 67 ft. $\frac{1}{16}$ in. c. to c. of piers, of which 41 ft. $11\frac{3}{16}$ in. is the suspended girder and 12 ft. $6\frac{3}{4}$ in. overhang on each end. Span 29-30 (the longest main span) has a central section varying from 57 ft. $3\frac{3}{16}$ in. on one outside girder to 65 ft. $2\frac{1}{16}$ in. on the opposite outside girder. Its overhangs bring its total outside girder length up to 91 ft. $5\frac{1}{16}$ in.

The combination expansion joint and support for the suspended span in this particular section is of great interest. Its detail is shown in Fig. 5. As will be seen in the other drawings and in the view in Fig. 7, the overhang of the cantilever is cast in steps. Into the forms at these steps was placed a frame of steelwork made up mainly of three longitudinal angles with their outstanding legs clipped off in order to allow them to be inserted between the reinforcement of the beams. The horizontal faces of these angles at their extremities carry flat bearing plates riveted to the angle with the upper plane face of the plate flush with the horizontal face of the concrete step. Similar angles are also placed in the forms for the suspended span, except that the horizontal leg of the angle is downward and that it carries a plate slightly beveled in order to form a rocker on the flat plate of the lower angle. Through this rocker bed a $\frac{3}{8}$-in. bolt is inserted to give proper alignment and bearing during construction. It is expected that any perceptible action of the rocker will soon shear the bolts and that the motion thereafter will be perfectly free. This rocker bearing is provided at each of the six longitudinal girders, which are in turn all thoroughly interbraced, so that in effect the suspended span is an integral structure carried

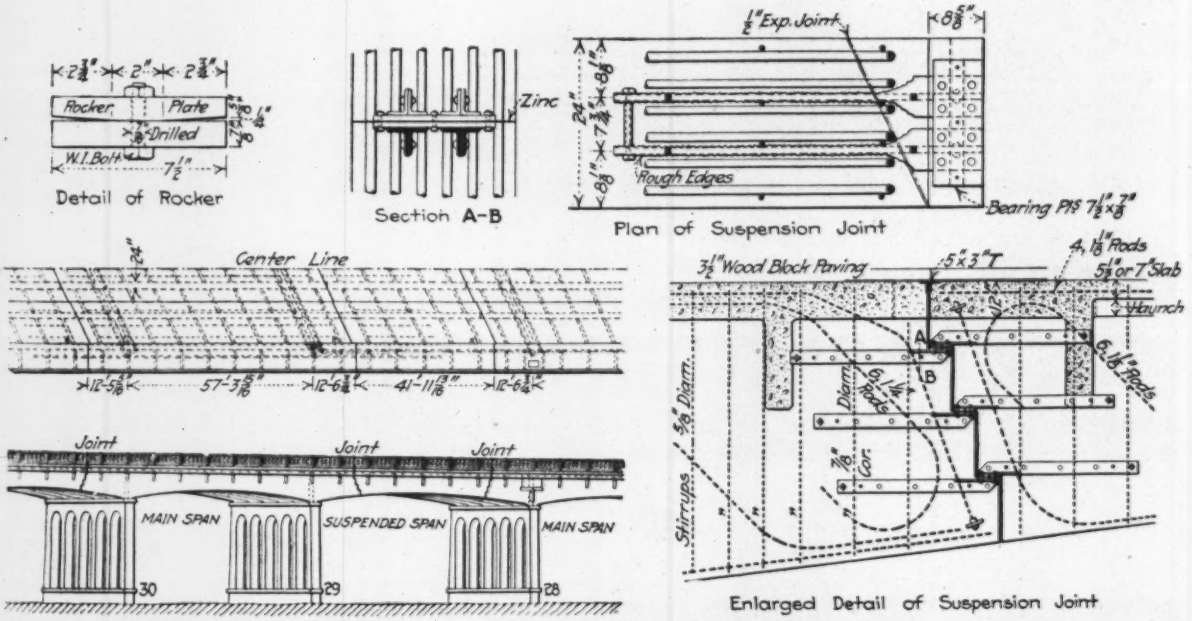


FIG. 5. PART OF THE MAIN NORTHERLY SECTION AND DETAILS OF THE SUSPENSION JOINT

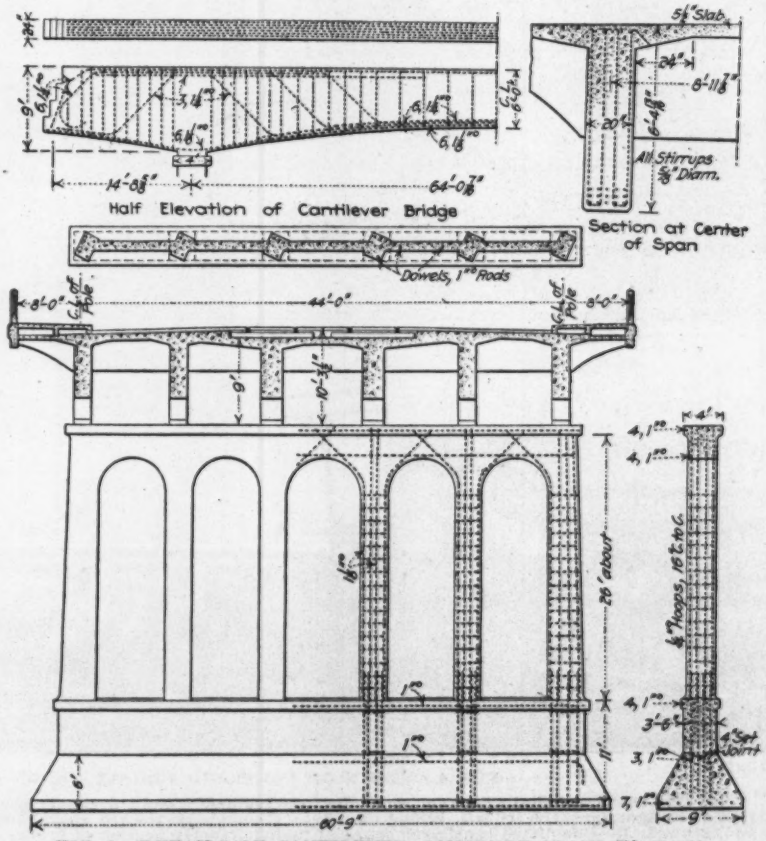


FIG. 6. DETAILS OF CANTILEVER CONCRETE SPANS IN MAIN NORTHERLY SECTION

on the numerous rockers at the joints of the overhanging cantilever girders.

The South Portland Approach

The concrete section at the south end of the bridge comprises a series of reinforced-concrete columns carrying straight cross-beams and curved longitudinal beams, on which the reinforced-concrete floor slab is cast. This exhibits no particular difficulty except that at every three spans there is a transverse wall breaking up the section into intermediate sections separated by expansion joints. There are three lines of columns, one on either side and one in the middle, each founded on prismatic pedestals footing on wooden piles which were mainly through a deep layer of silt.

The south approach is a fill made from a submarine borrow pit farther down the harbor, brought into the work by lighter and rehandled into the fill. It is held on the

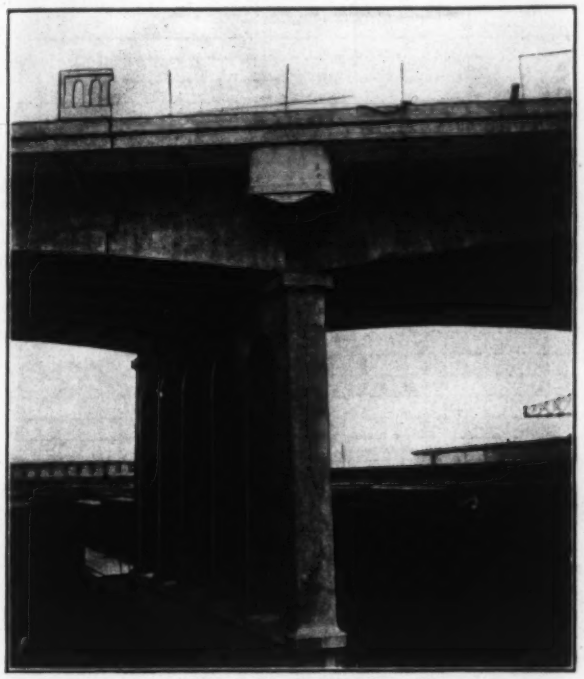


FIG. 7. NEAR VIEW OF THE COMBINED EXPANSION AND SUSPENSION JOINT ON MAIN SPAN

east side by the old bridge abutment wall topped by a new concrete wall, and on the other side has a heavy granite paving to protect the slope against wash.

Special Features of the Structure

Some special features in the detailing of the structure are common to various parts of the bridge and will be described separately. Among these are the use of separately cast sidewalk brackets, separately cast railing and specially cast manhole boxes.

It will be seen from the various drawings herewith that the sidewalk on the reinforced-concrete portion of the bridge is supported on reinforced-concrete brackets. These brackets are cast in Boston by Simpson Bros. in a sand mold; they are reinforced for their service, and the reinforcement is left protruding from the inner face so that when the castings are set in the forms the reinforcement may be tied back to the proper reinforcement in the structure proper. The aggregate used in the brackets is of similar nature to that used in the bridge, and the troweled surface given to the face is similar to that gained by the sand bed, so that in all ways they resemble very closely the structure in which they fit.

In the same manner are cast the railing sections, which go across the entire bridge. They are brought in from Boston, as are the brackets, on cars and are stored on the work until needed. The railings are placed on the bridge after the floor has been built and are boxed together at their joints with the reinforcement protruding into the opening. Into this box a joint is poured, making the railing continuous except at the expansion joints, where a special detail is provided.

The manholes for the conduits are of reinforced concrete and are so designed that the forms can all be set up on the ground and hoisted into place in their proper location, and the concrete poured around them to form the manhole.

Engineers and Contractors

The bridge is being built for Cumberland County, Me., under the direction of J. R. Worcester & Co., of Boston, Mass., as Engineers, with E. E. Pettee, of that firm, as Resident Engineer. The substructure contract was held by Holbrook, Cabot & Rollins, Inc., of Boston, with Luke S. White as superintendent and the superstructure contract by T. Stuart & Son Co., of Newton, Mass., with Albert T. Stuart, of the firm, as superintendent. The Phœnix Bridge Co. has the steel contract.

The details of the steelwork and the methods of construction will be described in future articles.

Life of Port Structures*

The life-expectancy factor frequently is given the least consideration in port and harbor design, if it is not entirely overlooked. "Life expectancy" as used here refers to the useful or commercial life that may be expected of a building. It has been estimated that the average commercial life of structures is about 30 yr. It is safe to assert that the physical life of a structure need exceed but little the commercial-life expectancy, in so far as the durability of materials is concerned.

On the Pacific Coast the timber or heavy mill type of pier and wharf construction is quite generally used. Experience at Seattle has shown that while it is necessary to creosote the piling as a protection against wood borers, yet the cost of a heavy fire-resisting timber structure is less than half one of concrete. By the installation of automatic fire sprinklers and fire-alarm and watchman's control systems a very favorable insurance rate was obtained. Upon analysis of the cost and the problable life of the structures the following facts were deduced:

1. With some redriving of piles, the timber pier may be expected to last from 20 to 25 yr., or about the effective commercial life.

2. Assuming the commercial life of a concrete pier to be 50 yr. and the physical life not less, also assuming that a timber pier would have to be entirely rebuilt at the end of 25 yr. at the close of the 50-yr. period—taking into consideration interest and other cost factors—the construction of timber piers would result in a saving of approximately 40%. In addition there would be the advantage resulting from the opportunity afforded at the end of 25 yr. of designing the new timber structure to meet changed requirements.

3. If the concrete type of pier had been adopted the available construction capital would not have provided more than half the facilities desired.

*Extracts from a paper presented by Paul P. Whitham before the American Association by Port Authorities, Los Angeles, Calif., Sept. 13, 1915.

Havana Rainfall Records

By Frank M. Aguirre*

In *Engineering News* of June 24, 1915, N. M. Stineman groups the New Bedford, Mass., century rainfall records into periods of 5, 10 and 20 yr., and states that it would be interesting to know whether other long rainfall records would show similar results.

In "Revista de la Sociedad Cubana de Ingenieros" for July, 1915, the rainfall records for Havana, Cuba, from 1859 to 1914 are published. I have placed this 56-yr. record in practically the same form as did Mr. Stineman the New Bedford records.

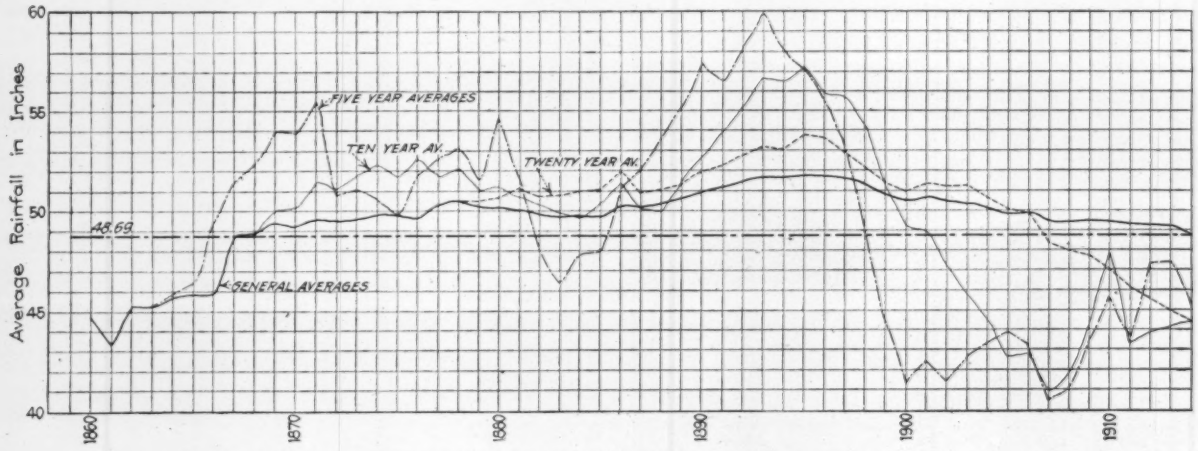
The maximum was in 1867, when 71.40 in. fell and the minimum was in 1907 with only 27.05 in. The average for the 56 years is 48.69 in. The 5-yr. averages vary from 40.4 in. in 1907 to 59.82 in. in 1893 or from 17% below the average for 56 yr. to 22.9% above this average. The 10-yr. averages vary from 40.86 in. in 1907 to 57.20 in. in 1895, or from 16.1% below the general average to 17.5% above. The 20-yr. averages vary from 44.47 in. in 1914 to 53.71 in. in 1895, or from 8.7% below the general average to 10.3% above. By these figures it is seen that although the variation above the general average appreciably decreases with the increase in length of period or of number of records, the variation below does not so decrease with the increase in length of period.

These figures are in accord with the New Bedford observations cited by Mr. Stineman and also with the Milwaukee records for 65 yr. presented by F. H. Millard in the same issue of *Engineering News*. Mr. Millard states that the variations above the average are considerably larger than those below, but the last statement in the preceding paragraph must be remembered, that with the increase in length of period the variation above the average decreases appreciably while the variation below does not.

One very significant fact shown by the accompanying diagram must strike terror to the promoter of water-power schemes who depends on rainfall data. From 1868 to 1914 the general average from year to year as the records increased in length was above that for the entire record; that is, the average from year to year during 46 yr. was above the general average of the 56-yr. record. In other words, if these data were used from 1869 to 1913, the averages in any of those years would have been higher than the average up to date.

Another fact to be noted, and which seems incongruous, is that the 10-yr. periods on four different occasions were nearer the general average of the 56 yr. than the general average for that year; that is, in 1887, 1888, 1900 and 1901. Thus we have a record of 10 yr. coming nearer the truth as shown by the 56-yr. record than the records for 3 yr. show, as in 1901, where the average of the 43 preceding years is 55.89 in. and the average of the 10 preceding years is 48.82 in., or very nearly the same as the average of the 56 yr., which is 48.69 in.

In general, the Havana records show the same characteristics as those of Milwaukee and of New Bedford, in spite of being shorter. They certainly make clear the uncertainty of records of a short duration, unless there is positive evidence that the period under consideration is a dry period, or *vice versa*.



YEARLY AND AVERAGE RAINFALLS BY PERIODS, HAVANA, CUBA, 1859 TO 1914

YEARLY AND AVERAGE RAINFALL AT HAVANA, CUBA, 1859 TO 1914 (EXPRESSED IN INCHES)

		Averages of Rainfall in Stated Periods						Averages of Rainfall in Stated Periods			
Year	Rainfall	All Years Previous	5 Yr. Previous	10 Yr. Previous	20 Yr. Previous	Year	Rainfall	All Years Previous	5 Yr. Previous	10 Yr. Previous	20 Yr. Previous
1859	44.84	.....	.....	.....	.....	1887	49.33	50.17	52.04	50.01	50.83
1860	44.45	44.65	.....	.....	.....	1888	53.51	50.28	53.53	49.96	51.02
1861	40.59	43.29	.....	.....	.....	1889	59.73	50.59	55.09	51.42	51.21
1862	51.29	45.30	.....	.....	.....						
1863	45.10	45.25	45.25	.....	.....	1890	59.73	50.87	57.37	52.60	51.89
1864	47.88	45.69	45.86	.....	.....	1891	59.73	51.14	56.41	53.73	52.18
						1892	58.30	51.35	58.20	55.12	52.70
1865	46.86	45.86	46.35	.....	.....	1893	60.59	51.62	59.82	56.57	53.16
1866	45.95	45.87	49.42	.....	.....	1894	50.71	51.59	57.81	56.45	53.03
1867	71.40	48.71	51.44	.....	.....						
1868	49.80	48.82	52.38	48.82	.....	1895	55.85	51.71	57.03	57.20	53.71
1869	55.79	49.45	53.98	49.91	.....	1896	51.06	51.69	55.30	55.85	53.57
						1897	46.21	51.55	52.88	55.54	52.78
1870	46.27	49.19	53.84	50.09	.....	1898	39.75	51.25	48.72	54.17	52.06
1871	53.84	49.54	55.42	51.42	.....	1899	28.71	50.70	44.32	51.06	51.24
1872	47.88	49.42	50.72	51.08	.....						
1873	51.47	49.56	51.05	51.71	.....	1900	41.12	50.48	41.37	49.20	50.90
1874	53.18	49.79	50.53	52.24	.....	1901	55.89	50.60	42.34	48.82	51.28
						1902	41.12	50.39	41.32	47.10	51.11
1875	42.31	49.76	49.74	51.79	.....	1903	46.56	50.30	42.68	45.70	51.13
1876	53.94	49.60	51.76	52.59	.....	1904	39.58	50.07	44.85	44.59	50.52
1877	62.01	50.26	52.58	51.65	.....						
1878	54.05	50.45	53.08	52.07	50.45	1905	36.32	49.78	43.89	42.63	49.92
1879	45.07	50.19	51.48	51.00	50.46	1906	52.48	49.83	43.21	42.77	49.81
						1907	27.05	49.37	40.40	40.86	48.20
1880	47.94	50.09	54.60	51.17	50.63	1908	49.13	49.36	40.91	41.79	47.89
1881	48.43	50.01	51.50	50.63	51.02	1909	52.50	49.42	43.49	44.18	47.62
1882	44.43	49.78	47.98	50.28	50.68						
1883	46.08	49.63	46.39	49.74	50.73	1910	46.60	49.37	45.55	47.72	46.96
1884	51.89	49.72	47.75	49.62	50.93	1911	41.76	49.22	43.41	43.31	46.06
						1912	46.80	49.18	47.36	43.88	45.49
1885	48.37	49.67	47.84	50.22	51.01	1913	49.25	49.18	47.38	44.15	44.92
1886	64.53	50.20	51.06	51.28	51.93	1914	41.69	48.69	45.22	44.36	44.47

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Surface Warnings of Street Subsurface Failures

By Robert Klotz*

That concrete forms the most satisfactory material for the support of street pavements is unquestionable, but the fact that the very qualities which render it so satisfactory for the purpose may at the same time result in a source of great danger does not seem to receive sufficient consideration. With pavement laid on sand or on the existing subsoil any subsurface voids caused by leaks from defective water mains or by defective sewers were followed shortly by a noticeable depression in the pavement, except in rare instances in which the blocks had been laid with very close joints and chanced to form an arch over the opening. When the depressions were slight they were, as a rule, occasioned by settlement of the subsoil, and the restoration of the pavement to grade was sufficient to eliminate the defect. Where conditions below the surface were serious, the condition of the pavement was indicative of the need for investigating the underlying mains or sewers, and the source of the trouble was soon located and removed.

With the introduction of the concrete base the practice of restoring the pavement over small depressions to grade without investigation of the underlying cause has been adhered to. However, the use of the monolithic base should naturally point to the necessity for a radical change, as its inherent power of bridging over a void of considerable area and volume should render the investigation of the cause of any noticeable depression of the concrete base obligatory.

An Example from New York City

A good example of the result of lack of appreciation of this requirement was the breaking of a 48-in. water main, with attendant damage to surrounding streets, on Manhattan Ave., New York City, on June 4, 1915.

An examination of the pavement surrounding the break shortly after its occurrence gave remarkably clear indication that the preliminary failure of the pipe had occurred some time before and that the leak had existed and had been washing away the subsoil for 5 or 6 yr.

Where the pavement had been broken out, the sections of the concrete base showed a thickness varying, over the entire street intersection, from 6 in., as called for by the specifications, to 22 in., the minimum thickness being adjacent to the street-railway tracks, which were carried on a masonry structure bridging the water mains and served to prevent the settlement of the pavement adjoining them. This heavy concrete showed distinctly that various layers, from 2 in. to 6 in. in thickness, had been applied from time to time to restore the settled pavement to its proper grade, and that this had been done over almost the entire area affected by the washout.

The continued settlement, as recorded in the many layers of added concrete, should have been recognized as an indication of some defect in one of the mains or sewers.

Further evidence of the need of examination of subsurface conditions was the settlement of the street-railway tracks on Manhattan Ave. between 109th and 110th St., which had been corrected some two years before, although it was, perhaps, excusable to attribute this settlement to the after effects of a severe washout at the north side of 110th St., which had occurred during the early part of 1910. The excessive thickness of the concrete explains the fact that a comparatively small area of pavement was displaced by the actual flow of water.

As the results of the washout required the reconstruction of the street-railway tracks and most of the subsurface structures in the entire block on Manhattan Ave. between 109th and 110th St., the reconstruction of about 200 ft. of double track on 8th Ave. (parallel to and over 400 ft. distant from Manhattan Ave.) and the restoration of portions of the roadways and sidewalks on Manhattan Ave. and on 110th St. at points 600 and 700 ft. distant from the location of the break, it may well be seen that even a very appreciable expenditure of money for the purpose of investigating the cause of the pavement settlement would have been a profitable investment.

As the district lying immediately east and north of the location of the break consists of land filled in on a base of riprap, it may also be assumed that additional settlements will occur from time to time at other points where the dirt has been washed into the voids of the riprap and where the pavement is now supported solely by the concrete base.

Upheaval Due to Gas Explosion

Another example of the preliminary surface indication of a water leak, although the evidence in this case was much less marked, was that resulting in the washout which caused illuminating-gas explosions and the consequent wrecking of the pavement on 23rd St. at 5th Ave., New York City, somewhat over a year earlier.

Early in 1912 a slight hole in the pavement and base along 23rd St. at the intersection of 5th Ave. revealed, upon investigation, a cavity approximately 6 ft. deep and about 4 ft. in diameter. Nothing was done at the time beyond filling in the cavity and restoring the pavement over the opening. As this cavity was located about 10 ft. directly west of the section of the water main which finally broke apart, there is no question but that it was caused by a minor leak existing in the main at that time or for some time before, and that an investigation would have disclosed the existence of undesirable conditions, the immediate correction of which would have avoided the damage resulting from the ultimate break.

That in either of these or in any such cases the initial cracking of the pipe is other than accidental is very doubtful, and the failures of cast-iron mains are too few to warrant any criticism of the accepted types of pipe or the manner of laying them.

The experience in the two cases cited, however, and in others in which slight surface defects have led to the uncovering of extensive cavities, clearly indicates the need of regarding settlements in pavements laid on concrete as a base as distinct warnings of subsurface defects, rather than as minor pavement defects to be corrected by restoring the surface. An investigation of a case of this kind need not necessarily involve extensive or expensive excavation. An examination of the interior of a sewer or a test of the water mains will often indicate the location of defects the existence of which has not been suspected. Where such an investigation yields no results and the settlement of the pavement continues, excavation should be resorted to, unless there is a definite and reliable record of a reasonable cause for the settlement.

*111 W. 49th St., New York City.

Sewer Gagings and Maximum Flow in a Seattle Outfall

By Henry D. Silliman*

SYNOPSIS—Sewer gagings and related data in a Seattle sewer district show that the maximum flow in the outfall sewer occurred about 10 min. after the time of greatest precipitation, as compared with a "running time" of 20 min. between the most distant manhole and the recording gage.

The purpose of this article is to show by records of both rainfall and runoff the truth of a theory used in the design of storm-water sewers and given by O. Hufeland in *Engineering News* of Nov. 5, 1914. The theory is that the maximum flow in an outfall sewer occurs at a period of time considerably less than that ordinarily given as the period or time of concentration, which is defined by Raikes as "the time actually required for the storm-water to flow through the sewer to the outfall."

The data here given in support of the theory just stated were secured during 1914 in the First Avenue intercepting-sewer district of Seattle, which is the only drainage district in the city that can be said to have attained its normal development. Fig. 1 is a map of the district, giving such available data as might aid in the study of the sewer gagings here reported.

Through the coöperation of George N. Salisbury, section director for the U. S. Weather Bureau, the rainfall data for the year 1914 have been obtained. As will be noted from the map (Fig. 1) the Weather-Bureau offices are located near the center of this district.

During the year 1914 there were four rainstorms of more than average intensity. For these storms the data given in the table beneath the caption of Fig. 2 were obtained.

The recording gages were made by the Bristol Co., the type of case used being that known as "moisture-proof." Less trouble would have resulted if their "water-proof" case had been used. It was also found that the pressure-diaphragm case acted as a grease trap, sufficient grease accumulating to affect the pliability of the diaphragm and to fill the inlet holes of the case.

*Assistant District Engineer, City Engineer's Office, Seattle, Wash.

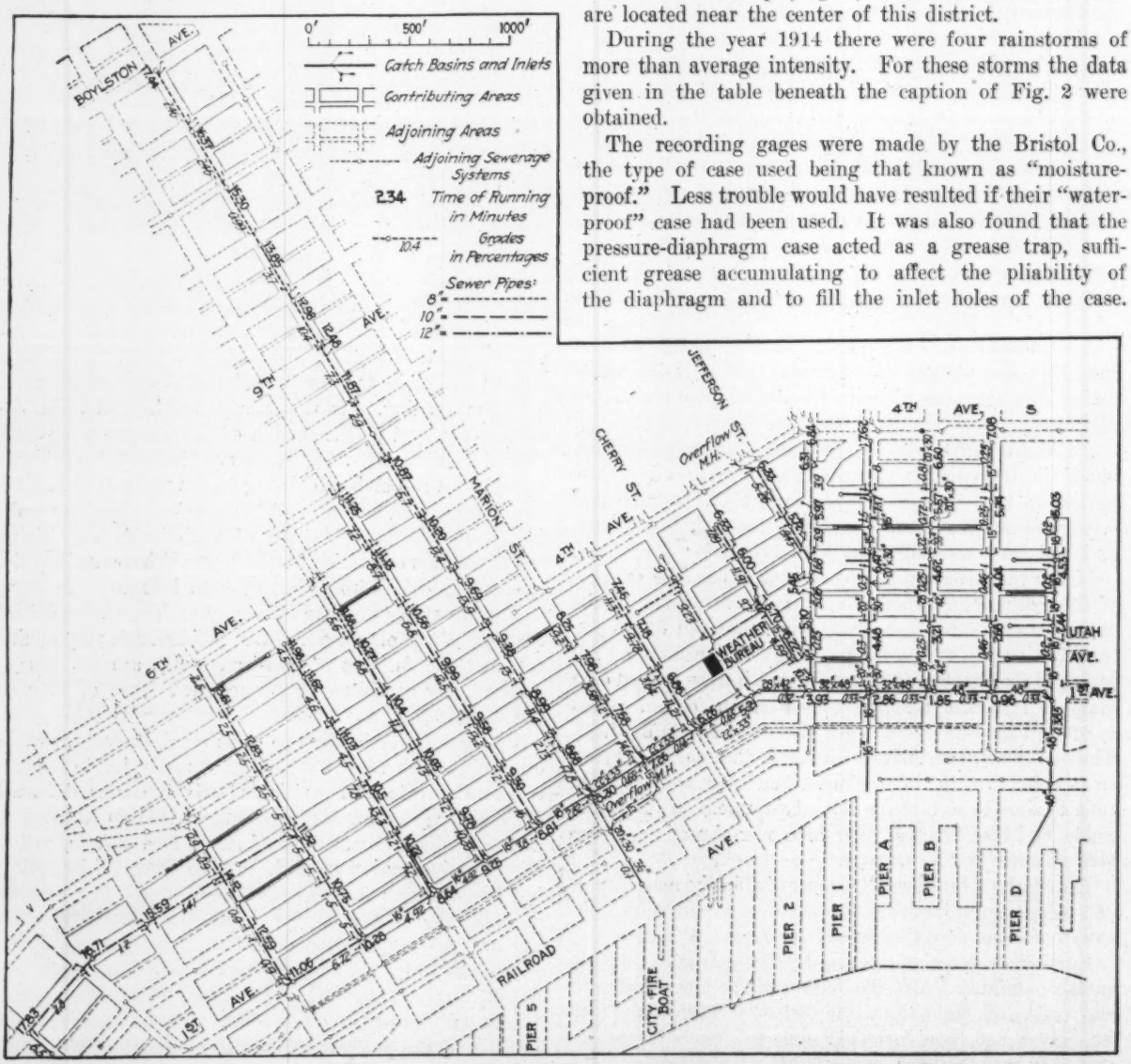


FIG. 1. MAP OF FIRST AVENUE INTERCEPTING SEWER DISTRICT, SEATTLE, WASH.

Estimated population, 26,000. Storm-water inlets, 273. Pavement and sidewalk area, 71.7 acres; built-over area, 61.3 acres; vacant or unpaved area, 23.4 acres; total contributing area bove recording gage, 156.4 acres

The pressure bulb, or case, was set 6 in. above and on the center line of the 48-in. sewer. The bulb was held in place by a collar of ¼x1-in. iron around a 2-in. galvanized-iron pipe secured by a trench-brace screw.

Large quantities of paper, laundry rags, etc., travel through this sewer. The charts show small fluctuations caused by this material gathering on the pressure bulb and its fastenings. After reaching a certain size, in about one hour, this accumulation did not increase. The charts were removed and the rags, paper, etc., cleared off each day except Sunday.

Referring to the map of the district (Fig. 1), it will be seen that the time of running in this sewer system from the manhole where the recording gage was installed to the

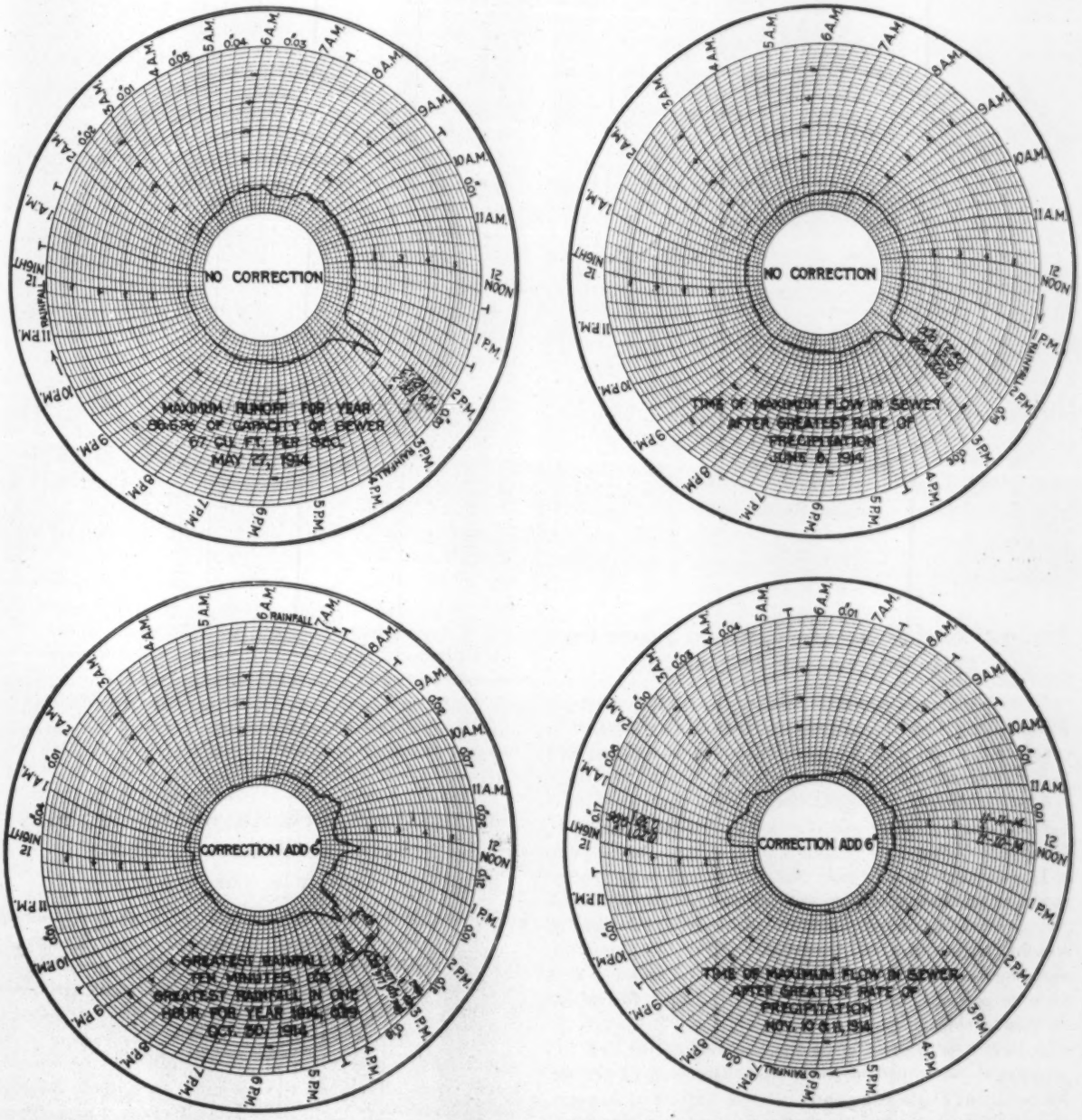


FIG. 2. DEPTHS OF SEWAGE FLOW AT SEATTLE, WASH., DURING FOUR HEAVIEST RAINFALLS OF 1914

Recorded on Bristol water-level gage in First Ave. intercepting sewer, a 48-in. circular sewer, with a 0.385-per cent. grade. The precipitation and runoff for the heaviest portions of these rainfalls were as follows:

Date	Time	Precipitation, In.	Runoff in Per Cent. of Rainfall
May 27, 1914	2:28 p.m. to 2:33 p.m.	0.07	
	2:38 p.m.	0.11	54.5
	2:43 p.m.	0.17	
	3:28 p.m.	0.20	
June 6, 1914	2:40 p.m. to 2:45 p.m.	0.03	
	2:50 p.m.	0.10	23.6
	2:55 p.m.	0.12	
	3:35 p.m.	0.21	
Oct. 30, 1914	3:07 p.m. to 3:12 p.m.	0.11	
	3:17 p.m.	0.13	33.4
	3:22 p.m.	0.14	
	3:45 p.m.	0.29	
Nov. 11, 1914	0:20 a.m. to 0:25 a.m.	0.03	
	0:30 a.m.	0.06	40.0
	0:35 a.m.	0.09	
	1:00 a.m.	0.17	

The percentages of runoff given in the column of the tabulation were calculated by dividing the estimated discharge through the sewer for the maximum depth of flow as shown on the accompanying charts taken from the recording gage on the days in which these storms occurred, less an amount equal to the discharge of sanitary sewage from this sewer in dry weather, by the amount of rainfall over the total area of the district for one minute, at an average rate for the ten-minute period having the greatest amount of precipitation

farthest removed storm-water inlet is approximately 20 min. Now, referring to the charts from the recording gage (Fig. 2), it will be seen that the maximum flow in the sewer occurred on or about ten minutes after the time of greatest precipitation.

These results, then, seem to affirm the conclusions of three American engineers, as follows:

The present percentage of rainfall discharged from the aforesaid urban districts cannot, however, be regarded as permanent, since improvements are constantly being made by the construction of new buildings, pavement and sewers. Hence, not only is the proportion of the impervious surface on these districts steadily growing, but the time required for the concentration of the storm water in the outlet sewers is also becoming materially reduced.—Emil Kuichling. "The Relation Between Rainfall and the Discharge of Sewers in Populous Districts." "Trans. Am. Soc. C. E.," Vol. XX.

The method of finding the time whose rate of precipitation would cause the maximum flood is then as follows:

1. Estimate the time in minutes required for the water to pass from the most distant inlet to A.

2. Take half this time and add eight minutes.

[A being any point on the outfall sewer, eight minutes equals time allowed for water to pass over roofs, pavements, etc., before reaching the sewer inlets.—Ernest Wilder Clarke, "Storm Flow from City Sewers," "Engineering News," Nov. 6, 1902.]

The method given demonstrates that the time of concentration is considerably less than the total time taken for sewage to flow to a given point on the outfall sewer from the farthest removed storm-water inlet.—O. Hufeland. "Graphic Method of Estimating Runoff in Storm Sewers." "Engineering News," Nov. 5, 1914.

These sewage gagings, together with gagings of the flow in some of the larger trunk sewers, for whose drainage districts such complete data could not be offered, were made by me during the year 1914, under the direction of A. H. Dimock, City Engineer of Seattle.

Selecting Rural-Road Types for the State of Illinois*

In order to select the economic type of improvement for the main rural highways of Illinois it is necessary to consider the first cost, the interest on the investment and the maintenance cost.

The problem is in a great many respects directly comparable with the cost of service in railroad transportation, in electric lighting, telephone and telegraph service, etc.

In general it may be said that if the traffic and type of road are properly suited to each other, the cost of service for hard roads is approximately constant for all types of wearing surfaces. Cost of service in this connection is understood to mean the total cost per unit of area per unit of time per unit of load, and to be constant for an indefinite period of time.

It should be kept in mind that the cost of the first improvement bears very directly upon this cost of service, for money at 3½% compound interest doubles in 20 years, and at 5% in 14 years. So that as the first cost goes down, the saving on money invested may be an appreciable item in providing a fund for the purpose of maintaining the roads to a desired standard of excellence and usefulness. In this way, where the lighter types of improvement are sufficient to meet the demands of traffic, it is wasteful to invest money where it serves no purpose. Later on the amount so saved might be used for the purpose of resurfacing the road to meet the increased demands of a greater volume and a changed character of traffic.

*Extracts from a special official report of William W. Marr, Chief Highway Engineer, Springfield, Ill.

Another important factor that should not be overlooked is that the more roads built the easier, and consequently the cheaper it is to build them. This has a double significance, in that the sooner hard roads are in service, the sooner and more generally will their advantages be felt, and also in that the cost of reconstruction will be less proportionately than the cost of first construction, because of the increased facilities for handling materials over better roads.

As to the type of road which the state could assume the burden of maintaining, no one, two or three types could possibly meet economically the wide range of conditions to be found on the 16,000 mi. of designated state-aid roads in Illinois.

The types of pavements which might properly be adopted for main rural highways in Illinois cover a wide range and depend upon cost, which varies with availability of materials; traffic, which varies in amount and kind with different locations, and local preference, which changes largely with popular sentiment.

The state might reasonably assume the burden of maintaining a pavement regardless of type, if the traffic is proportioned to the ability of the particular type in question to resist the wear occasioned by the traffic.

The state might coöperate with the county to share a portion of the cost of maintenance where the type of pavement selected is only partly able to withstand economically the burden of traffic which will come upon it. The state should not assume any portion of the cost of maintaining earth roads unless the partnership between the state and county were extended to cover the entire item of maintenance, in which case an equitable solution of the problem would appear to be an equal division of the cost of maintenance between the state and county.

I recommend that the state adopt some comprehensive scheme for taking a census of traffic and gathering such other information as is necessary for the proper scientific solution of the problem of determining upon its economic types of roads for various localities and conditions.

Handling Bricks with Gravity Roller Conveyors

By W. B. Conant*

Roller gravity conveyors for moving bricks and mortar in mill construction, with an endless-chain elevator to raise the brick trays and mortar boxes from ground level to the scaffolding, have been used by the Aberthaw Construction Co., of Boston, Mass., in several recent factory contracts. A good example of their application is to be seen in the construction of a new mill for the Farrell Foundry and Machine Co., Ansonia, Conn., the conveyors being obtained from the Matthews Gravity Carrier Co., Elwood City, Penn. They consisted of 4-ft. and 8-ft. frames containing rollers 14 in. long and 2¼ in. in diameter, laid 4¼ in. c. to c. Curves of 45° and 90°, in 8-ft. sections, were provided for conveying materials around some very sharp turns.

The cars which delivered the bricks were placed on a siding alongside the job, the bricks being piled into trays inside the car. One of the roller gravity conveyors led into the car (Fig. 2), and on this the trays were laid and transported 120 ft. by their own momentum, turning at

*Concord, Mass.

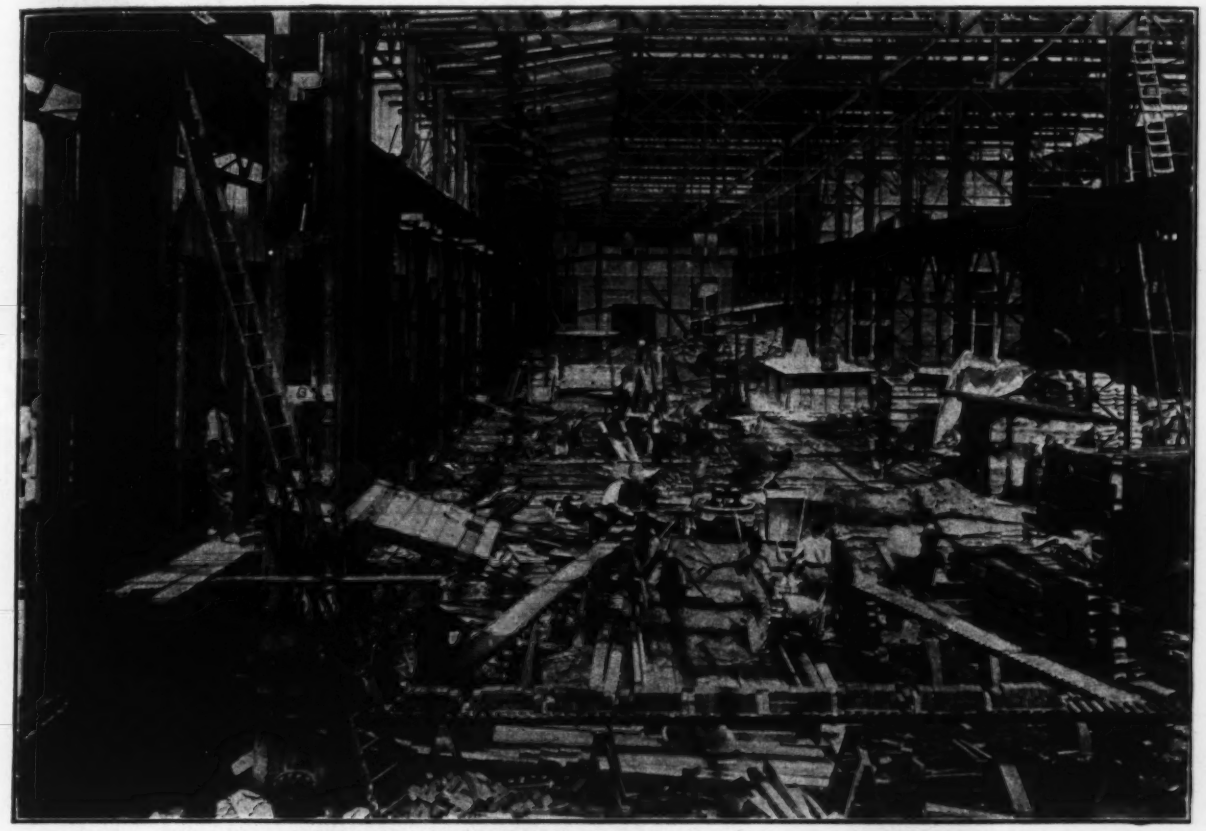


FIG. 1. ROLLER CONVEYORS FOR BRICK AND MORTAR AT THE FARRELL FOUNDRY, ANSONIA, CONN.
Distributing roller conveyor leads from far end of platform at left, out to the scaffold

right angles and coming to the foot of the elevator, 5 or 6 ft. below their starting point.

The elevator was of the endless-chain type, having protruding fingers on which the trays were placed. It was driven by a 3-hp. electric motor, the rise being 60 ft. The most economical speed for the elevator was found to be about 45 ft. per min., at which rate one elevator will supply 45,000 trays of brick or boxes of mortar per 8-hr. day.

The elevator lifted to a platform, which also served as the starting point for the roller carrier. The scaffolds

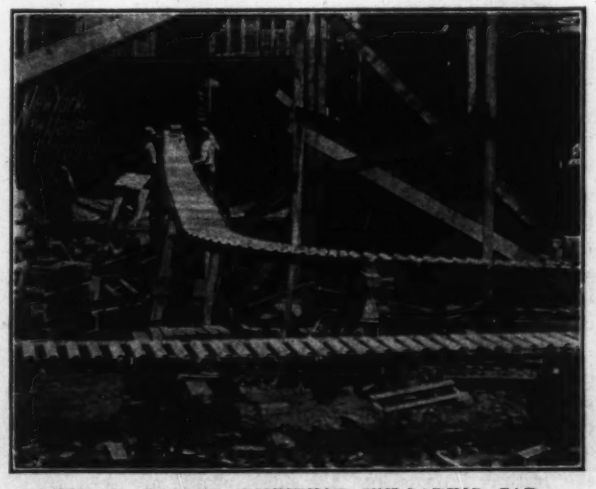


FIG. 2. ROLLER CONVEYOR UNLOADING CAR

employed were furnished by the Patent Scaffolding Co., of New York City, and the loading platform previously mentioned was raised by the same type of mechanism which operated the scaffolds. A man stationed on the platform lifted the trays from the elevator and set them on the conveyor, which ran at right angles after emerging from the building, and continued along a staging which was placed behind the masons. Men at the back of the scaffold transferred the trays from the carrier to the bricklayers' tables. The scaffold and the platform were maintained at the same elevation.

Mortar was handled conveniently and economically by this system, both on the ground and on the scaffold. The containers were made of No. 14-gage sheet iron with electrically welded joints, or of 7/8-in. board lined with zinc and holding a hodful (about 125 lb.). Wheelbarrows were entirely dispensed with on the Ansonia construction.

Chain Elevator vs. Hod Hoist

The chain type of elevator requires very little power, and costs for freight and installing are less than for an elevator of the platform type. Where the platform elevator is used it should always be under the direction of the brick foreman (and no one else), if speed and economy are the chief considerations. In constructing buildings 100 ft. or more in height a platform hoist appears to be a necessity. Every elevator, whether of platform or chain type, requires two men—one to load and one to unload. Intrusting these operations to the men who are wheeling materials is sure to cause delay and congestion, and is at all times an unsafe practice.

Newark Railway Terminal and Utilities Building

SYNOPSIS—Second article on the Newark street-railway terminal of the Public Service Ry. Design of transportation facilities on subway, elevated and exchange concourse floors. Construction to carry heavy moving loads under an office building. Typical office-floor arrangements.

The congestion of traffic at the intersection of the two main arteries of travel in Newark, N. J.—Broad and Market St.—and the plan to divert the street cars from this point to a double-deck exchange terminal for the several lines were described in *Engineering News* of Oct. 7, 1915. It is sufficient to note here that surface cars from the west are brought into a subsurface station through a short approach subway and those from the north, east and south come in from the rear to an elevated station. This is directly over the other, but an exchange concourse (at street level) is between them. The design of the terminal building from both a transportation and a structural standpoint is unusually interesting. The main entrance, shown in Fig. 1, is on Park Place, where there is a frontage of 184 ft. The main building extends back some 350 ft. to Pine St. and has entrance wings to East Park and North Canal St. Property is required east of Pine St. for elevated-track approaches, but this is not built on, except for a large single-story garage under the tracks. In the architectural treatment of the front large arches and a heavy marquise over the sidewalks have been employed to suggest the effect of a railroad station; but all deep reveals and heavy cornices which might collect dirt and ice have been avoided. This elevation will be finished in blue Indiana limestone. The rest of the building will be finished in buff brick. The front will be illuminated at night by projectors along the edge of the marquise.

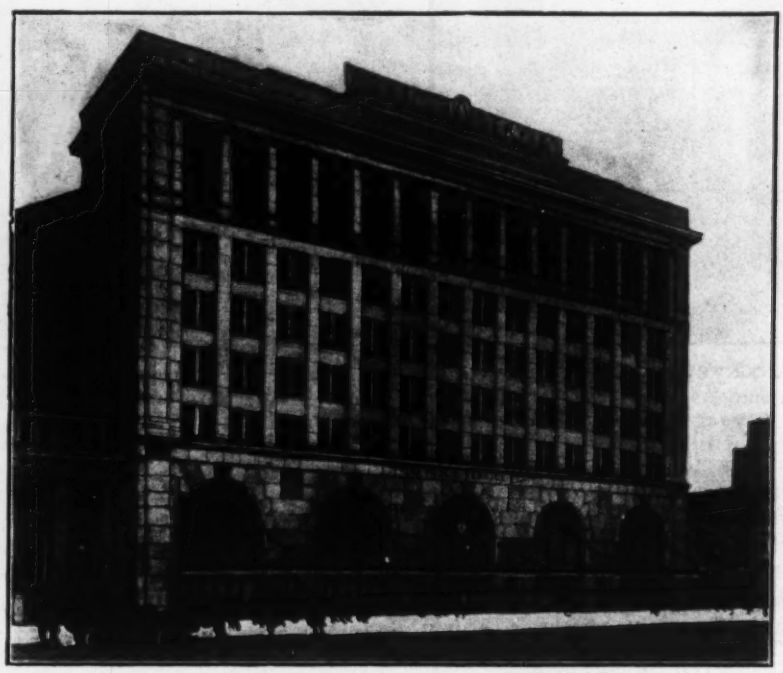


FIG. 1. TERMINAL AND OFFICE BUILDING, PUBLIC SERVICE RY., PARK PLACE, NEWARK, N. J.

Street-Railway Facilities

The floor and track plans for the subway, concourse and elevated levels are shown in Fig. 2. The subway floor is 21 ft. below street curb; the platform and rails are at the same level. A single incoming track divides into two unloading tracks on the south side, each 280 ft. long and providing trackage for a total of 10 cars. These two tracks converge on a loop (50-ft. radius) and come back to three 225-ft. loading tracks on the north side. These in turn lead to the outgoing line of the subway. From the unloading side four stairways lead up and seven go down to the loading platforms. (The basement of the wing to East Park St. will be used for boiler and service plant; the North Canal St. wing will house the building superintendent, service shops and storage. Some spare room on the Park Place front will be used by the Public Service companies' mailing department, to which a chute and elevator deliver.)

The elevated transportation floor is similar in scheme, but reversed to bring the loading platform directly over the subway unloading side. There are two unloading tracks, 140 and 170 ft. long, and three for loading, 140, 180 and 190 ft. long. Between the concourse and elevated loading platforms there are six stairways, with five on the unloading side. On the elevated level in the East Park St. wing will be the service-plant coal-storage and conveying machinery, and in the North Canal St. wing will be the railway division offices and the employment bureau of all the companies.

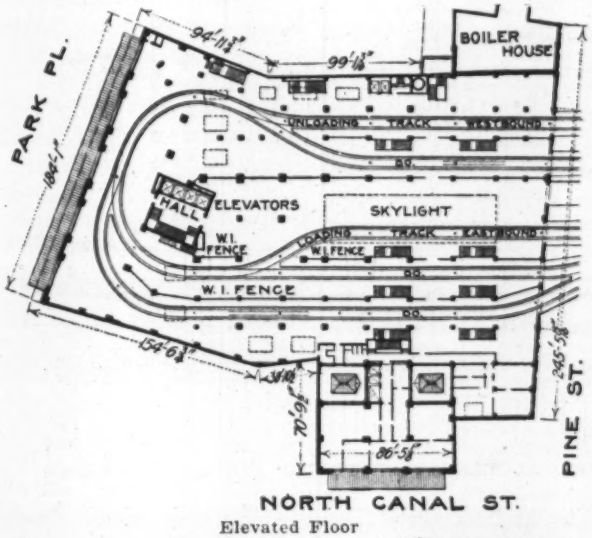
The street-level floor, besides serving as a concourse, with waiting and toilet rooms, information and parcel booths, soda and news stands and other renting space, will be used for the show rooms and order departments of the allied gas and electric companies. It is expected that this location will secure the maximum possible attention from these companies' patrons. The terminal station master and the railway instruction school will be quartered on this floor. Here also will be the coat rooms for an assembly hall above.

The main elevators rise from the front of the concourse, though there are smaller groups in the north and south wings. The main shaft rises through the elevated-track loop and does not extend below the street level. The arrangements for preventing interference between the railway crowds and the office people are seen from

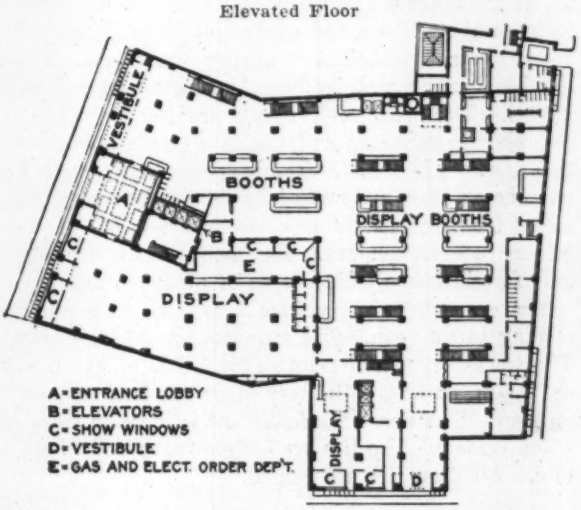
the concourse plan; yet the elevators are accessible to persons entering and leaving the concourse.

The floor space is divided thus (square feet):

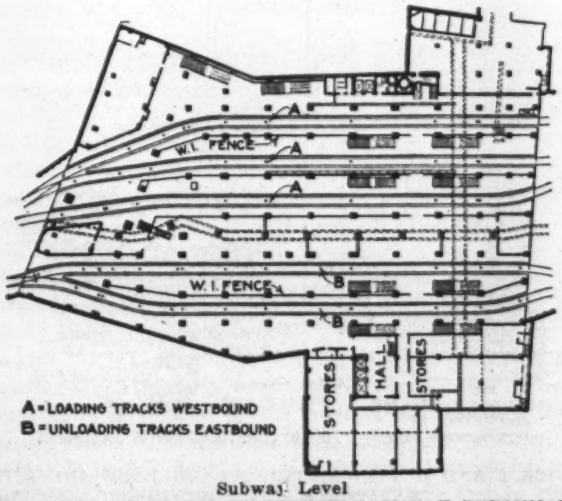
Subway	104,000
Concourse	70,000
Elevated	70,000
Six office floors	180,000
Kitchen and pent house	12,000
Total	436,000



Elevated Floor



Concourse Level



Subway Level

FIG. 2. FLOOR PLANS OF STREET-RAILWAY TERMINAL

The offices are to be used entirely by the Public Service Corporation and the operating railway, electric and gas companies.

Arrangement of Office Floors

Extending above the elevated-train floor are six office stories, each with 30,000 sq.ft. A typical floor (that of the railway company) is shown in Fig. 3. The peculiar shape is due partly to the property lines and partly to the necessity of securing a maximum amount of light and air. Each wing of the office structure is only two rooms deep, so that all offices will have outside windows.

The third story is to be used for the gas and electric companies' commercial-bookkeeping and complaint departments and the closely related offices. The fourth story will provide quarters for the treasurer of the holding corporation, the auditing departments of the gas and electric companies and a general assembly hall. In the fifth story will be the rest of the gas-company offices, the auditing department of the railway company and the publicity departments of all the companies. In the sixth story (Fig. 3) will be the offices of the railway company; in the seventh story will be the legal, claim, real-estate and welfare departments of the parent corporation,

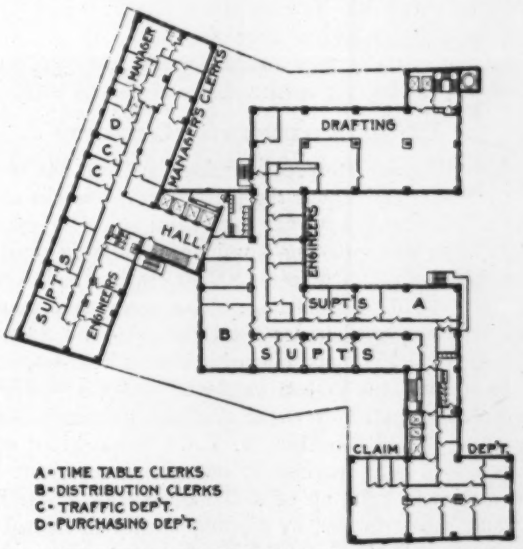


FIG. 3. RAILWAY OFFICE FLOOR, PUBLIC SERVICE TERMINAL BUILDING

the operating officers of the electric company and the law and technical library. The eighth story will be left for the executive offices, the general claim department and the officers' and employees' dining rooms. Over the eighth story will be the kitchen.

Foundations for the Structure

Because of the introduction of a railway terminal, with heavy moving loads, in a large office building, careful consideration was given to the foundations. Test borings for depth of foundations were made to bedrock at various locations over the site of the terminal and subway. The overlying material was fairly regular, and shale rock was found at approximately 55 ft. below the curb. A 15x15-ft. test pit was sunk to disclose the exact nature of the excavation and ground-water conditions.

The effect of traffic-produced vibration on the office structure and on neighboring buildings had to be con-

sidered. Two schemes of construction to avoid trouble were given consideration. One was to have a set of columns for the train floors and a separate set for the office building. The other plan was to use a single set of piers going down to bedrock and to carry the elevated-railway loads on a deep floor system supported by the building columns.

This second plan was adopted partly because the heavy floors would deaden the noise and reduce the vibration from the cars and partly because a single set of columns was very desirable in providing ample clearance for train operation. The foundation piers are from 6 to 12 ft. in diameter and were carried down to rock by air caissons. The building columns are carried on a grillage of steel I-beams as shown in Fig. 5.

The spoil removed in excavating for the foundations was loaded upon motor trucks and carried to a right-of-way which the railway company is building across the Newark Meadows. The contractors had a large fleet of these motor trucks, with a garage and repair shop, on the premises, during the earlier stages of construction.

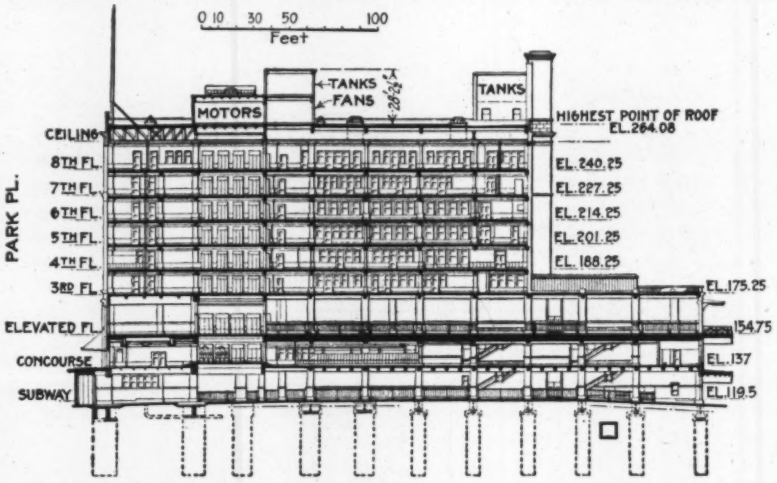


FIG. 4. SECTIONAL ELEVATION, PUBLIC SERVICE TERMINAL

Unique Waterproofing Completed

A continuous waterproof envelope has been put around the grillages and under the platforms and tracks of the entire building and subway to shut off ground-water contact. The waterproofing is unique in building construction because of its extent (500,000 sq.ft.) and because of its evident completeness. The same waterproofing has been employed under the elevated-station floor and approach track, toilets, blueprint rooms, kitchens, etc.

In general the system employed was the "Larutan" system, originated by Oscar Sheffield (Masonry Waterproofing Co., of Brooklyn, N. Y.). It was given severe tests before being specified by the railway engineers. The membrane is built up of a single layer of 1/8-in. bituminous sheets formed by dipping muslin in melted imported asphalt (kept at 225° F.). On this job two sheets lapped under water have been shown to cement perfectly. Great adhesion to concrete or grout deposited wet upon it was developed, due to the penetration of the asphalt.

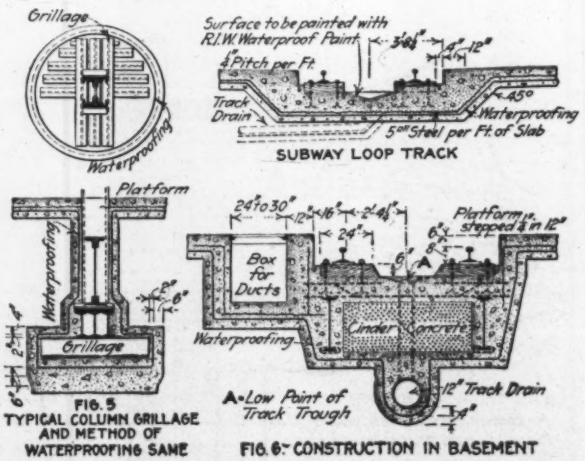
Steel Structure of the Terminal

The building as a steel structure has its greatest interest for the first three floors above the foundation. The office floors are of the usual type. There is in the upper structure, however, the somewhat unusual provision of a 5-ft. space between the roof and the ceiling of the upper floor. This serves as a pipe gallery for the heating system. The floor of this gallery is of reinforced cinder concrete suspended by structural-steel hangers from above and designed to carry a load of 45 lb. per sq.ft. In this gallery space at one place there is a heavy latticed truss from which a line of hanger members support the four floors below—to allow the auditorium in the fourth story to have a clear seating space.

The steel-frame members throughout the whole building have been given a proprietary anti-corrosive paint ("Tockolith"), selected for maintenance of concrete bond.

On the subway floor between the columns transversely and just above the grillages are built-up cross-girders (Fig. 5), and framed between these are stringers parallel to the track above (Fig. 6). The cross-girders rest directly on the grillages and are not joined to the columns, except by a loose-bolted steadying connection. Track live loads are figured for lines of 40-ton cars and 25% impact. The platform live-loads are 150 lb. per sq.ft. Between the stringers and ties is a reinforced-concrete slab as shown in Fig. 6. The passenger platforms, a 12-in. concrete slab, are carried by the fill between tracks, except for the relatively unimportant action of the cross-girders between columns. The platforms are reinforced only for shrinkage with a layer of expanded metal.

The cross-girders vary from 3 to 5 ft. in depth, according to the span. The stringers are 24-in. I-beams. The track-slab reinforcement (Fig. 6) is of 5/8-in. rods on 7½-in. centers, with every other rod bent up over a stringer. The upper reinforcement is of 5/8-in. rods on 15-in. centers. The ties are 6x8x26 in. spaced 24 in. c. to c. All these ties are treated.



FIGS. 5 AND 6. TYPICAL COLUMN GRILLAGE AND SUBWAY TRACK CONSTRUCTION

The construction for the subway loop is varied somewhat, since this is not in the main building but under the elevated approach. The short ties are used bolted to a concrete bed on earth and the waterproofing is carried under the track and floor.

The elevated railway-floor framing (designed for live loads of 100 lb. per sq.ft. up to 6 ft. from track centers and car lines of 40-ton cars with 50% impact) consists typically of 48-in. plate girders spanning 28 ft. between columns and 24-in. I-beams 4 ft. 8 in. apart. Above the floor framing are track stringers parallel to the rails. The track construction is very similar to that on the subway level, except that the ties (treated) are 5x8x27 in. and spaced 2 ft. c. to c. The passenger platforms are reinforced-concrete slabs resting on the floor-beams.

The elevated-approach structure between Mulberry and Pine St. is a steel frame with heavy concrete incasement. The space here over the subway loop and

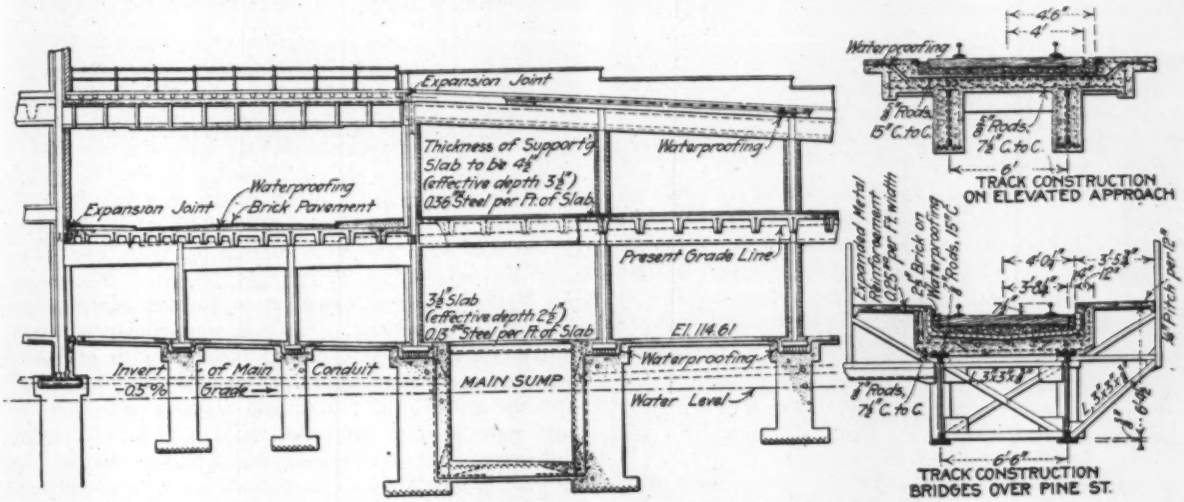

Expansion Joint
Thickness of Support's Slab to be 4½" (effective depth 3½") 0.36 Steel per Ft. of Slab
Waterproofing
Expansion Joint
Waterproofing Brick Pavement
Present Grade Line
3½" Slab (effective depth 2½") 0.13 Steel per Ft. of Slab
El. 114.61
Waterproofing
Invert -0.5% of Main Grade
Conduit
MAIN SUMP
Water Level
Waterproofing
⅝" Rods 15" C. to C.
⅝" Rods 7½" C. to C.
TRACK CONSTRUCTION ON ELEVATED APPROACH
Expanded Metal Reinforcement 0.25 lb. per Ft. Width
2½" Brick on Waterproofing
⅝" Rods, 15" C.
⅝" Rods 7½" C. to C.
TRACK CONSTRUCTION BRIDGES OVER PINE ST.

FIG. 7. PART OF ELEVATED APPROACH AND BRIDGES

under the elevated tracks is inclosed as a 45-car garage for companies' and officials' automobiles. Typical construction is shown in Fig. 7.

The trolley wires will be carried through the subway and on the two station floors by bar and hanger in a pine trough fastened to strong cross-pieces and iron hangers.

Roofs, Floors and Interior Finish

All the roofing will be of tarred felt, pitch and slag (or over the office section a wearing surface of ¼x3x6-in. slate will be substituted for the slag).

In the railway terminal the floors have a finish of 1:1 mortar, except that where there is heavy passenger exchanges the surface is 1:1:1 sand, cement and carborundum, treated to prevent dusting.

Only the first three floors are concrete slabs; above is hollow tile (Burchartz two-way system) with 6 to 8 in. of cinder concrete in which floor sleepers are embedded. Most offices have finished floors of 1⅛x2½-in. quarter-sawed Georgia pine. Cork tile on the cinder concrete is to be used in the kitchens, libraries and assembly room. The main executive offices have oak floors.

Marble mosaic floors are used for the entrance lobby, important public spaces on the office floors and in the officers' dining room. Terraza floors are specified for the entire concourse, elevator and stair halls and employees' dining room. The main entrance lobby, elevator hall and concourse will have marble trim. The office-section trim will be quartered oak.

Light, Heat and Other Services

The building will be equipped for illumination by both gas and electricity (combination fixtures). The gas supply comes to an 8-in. header in the North Canal St. basement, from which 4-in. risers supply the various floors. Current will be brought in at high-tension and transformed for a 110- and 220-volt single-phase 60-cycle three-wire system. For power there will be 550-volt direct-current lines. The building feeders will start at a main switchboard and run through a transverse tunnel below the subway level to three electric shafts which have service panels at the several floors. The floor wiring is to be installed in rigid conduits embedded in the concrete fill.

There will be a complete system of call bells, annunciators, telephones, fire-alarms, watchman recorders and electric clocks. In the switchboard room (basement) two small motor-generator sets will step down direct current from 550 volts to 30 to supply the watchman's clocks, fire-alarm boxes, bells, signals, etc. An operating room for the telephone service of the whole building will be provided on the fifth floor.

For heating there are five 6x19-ft. return-tube firebox-type boilers, each capable of carrying 16,600 sq.ft. of radiation. A vacuum system will be employed with the distributing mains in the roof space and risers feeding downward. The returns will be collected in the ceiling of the subway and run to the boiler room. This arrangement is made necessary on account of the lack of ceiling space in the railway floors. Two 20-hp. motor-driven vacuum pumps will be used.

Parts of the concourse floor and all of the larger offices, bookkeeping and drafting rooms, etc., will be mechanically ventilated with washed and tempered air. For this there are two separate plants. One with two supply and two exhaust fans, handling 35,000 cu.ft. of air, is in the basement boiler room and distributes to four floors above

the basement. The second air-washing plant, with two supply and three vent fans, handling 40,000 cu.ft. of air, is in a pent house above the roof and distributes downward to four floors. All fans are motor driven.

Drainage water from the subway and such parts of the terminal as are below street grade is collected in a main sump under the subway loop and is discharged by two centrifugal pumps each having a capacity of 400 gal. per min. and driven by a 7½-hp. motor. Sewage from low levels of the building goes to a separate sump and is lifted 35 ft. into the city sewers by three air ejectors, each of 150 gal. per min. capacity and all supplied from two motor-driven compressors.

The water-supply is taken from the city low-pressure main to the boiler room, whence it is distributed. Automatic motor-driven force pumps (two 6x8-in. triplex, 150-gal. units, with 7½-hp. motors) supply three 10,000-gal. cross-connected tanks on the roof. These tanks are connected to the city high-pressure fire service. From the tanks 2½-in. down-supply lines run to various parts of the building, including the fire-hose outlets. A 5-in. line comes down to a hot-water heating tank and boiler. The hot water is circulated by two triplex 150-gal. pumps giving 70 lb. pressure. Cooled drinking water is supplied to fountains throughout the building.

There are three sets of elevators serving the office floors. The main group is near the Park Place entrance, and here are three having a capacity of 4,000 lb. at 450 ft. per min. and one of 4,500-lb. capacity. Near the East Park St. entrance are two of 3,000-lb. capacity at 450 ft. per min. Near the North Canal St. entrance are two of 3,000-lb. capacity and one of 5,000-lb. capacity at 450 ft. per min. (9,000 lb. at slow speed).

Engineering Work

The engineering required for this terminal project was unusually extensive. It was decided to organize a special force to prepare the plans and specifications, and this organization was made an expansion of the railway-engineering department under the engineer of maintenance of way and with an assistant engineer devoting all of his time to the terminal. The special force included an architect, also track, structural, heating and ventilating and electrical engineers, besides the consulting engineers and consulting architects.

Plans and specifications were completed before any tenders were asked. All equipment, such as lighting and heating, was detailed down to the size and location of pipes and conduits. Even the location of each telephone was fixed. Nothing was left to the contractors to assume. The advisability of going to the time and expense of such completeness was indicated by the slight variation in the contractors' proposals for the superstructure. Proposals were made by eleven contractors, and there was only about 10% difference between the lowest and highest bid. Three of the lowest proposals varied only 1.8%. The total cost of real estate, building and financing is approximately is $5,500,000. The 1,000-ft. subway cost approximately $350,000 more. Various expenditures are not included in these figures—such as the necessary rerouting of tracks elsewhere in the city, as noted in *Engineering News* of Oct. 7, 1915. The excavation amounted to 100,000 cu.yd.; concrete, 92,000 cu.yd., and steelwork, 9,000 tons.

As explained more in detail in a previous article, the general scheme of a railway terminal and the double-decked arrangement employed were the ideas of T. N. McCarter, president of the Public Service Corporation and of the allied railway, gas and electric companies. The project has been under the general supervision of Martin Schreiber as Engineer of Maintenance of Way for the Public Service Ry. C. F. Bedwell has been the engineer in charge. Jacobs & Davies were the consulting engineers on the subway and foundations and George B. Post & Sons were consulting architects.

The contract for the subway, the building excavation and the foundations was let to the Holbrook, Cabot & Rollins Corporation, of New York City. The superstructure and remaining work were awarded to the Hedden Construction Co., of New York. The Hay Foundry and Iron Works, of Newark, was the subcontractor for the steelwork covered by both main contracts. The steel erection was finished Sept. 23. Six floors were completed Oct. 15.

Laying New Rails on Old Ties Embedded in Concrete

The United Railways Co., of St. Louis, Mo., has completed the reconstruction of its tracks on Olive St., between 14th St. and Pendleton Ave. The old tracks were laid early in 1906 and were constructed with 9-in. 112-lb. girder rails of the Trilby type, in which the guard side of the groove is extended to form a bearing for wheels of street vehicles. The rails were supported upon cypress ties 24 in. c. to c. and fastened with ordinary hook-head spikes, $5\frac{1}{2}$x$\frac{9}{16}$ in. Brace tie-plates on alternate ties and ⅞-in. round iron tie-rods placed 6 ft. apart were used to hold the rails to gage. The rail joints were of the cast-welded type, 14 in. long and weighing 270 lb. per joint. The cypress ties were completely surrounded by concrete, which extended 6 in. below the bottom of the ties and 3 in. beyond their ends. The top of the concrete was 2 in. above the top of the ties where the tracks were paved with granite blocks and 4 in. higher where they were paved with asphalt.

At the time this track was laid it was estimated that the concrete type of foundation would outlast several sets of rails and that a new set of rails could be laid upon the old ties when the first set had become worn out. This was based on the theory that the ties would be preserved by the concrete and protected against mechanical wear under the rails by the steel tie-plates. After more than nine years' heavy service the first rails were worn out and it was necessary to lay new ones. Test excavation showed that the foundation was in good condition, so it was decided to lay the new rails on the old ties as originally planned.

When the reconstruction work was started it was found that the concrete had not been damaged and that the ties were wet and in excellent condition, free from rot and uninjured by mechanical wear. None of these ties had been treated with preservative, and their soundness is due probably to the fact that they remained wet and were free from alternating wetting and drying or freezing and thawing.

The new rails are of the same type, 9 in. high and weighing 132 lb. per yd. The rail section is heavily

reinforced at points where the old rails had been found weak, and it is thought that at least 15 years' service can be secured. About 500 ft. of track was laid with 100-lb. T-rail of the A. R. A. section, in order to demonstrate its wearing quality.

The rails were fastened to the old ties by means of 1¼-in. screw spikes 6 in. long, driven by means of a portable electric machine. Spike holes of ¾-in. diameter were bored in the ties by a similar machine. The ties are protected against mechanical wear by flat tie-plates ½ in. thick, but varying in thickness whenever necessary to bring the new rails to a perfect surface. Tie-rods ⅞ in. diameter were placed 6 ft. apart to assist in holding the rails to gage.

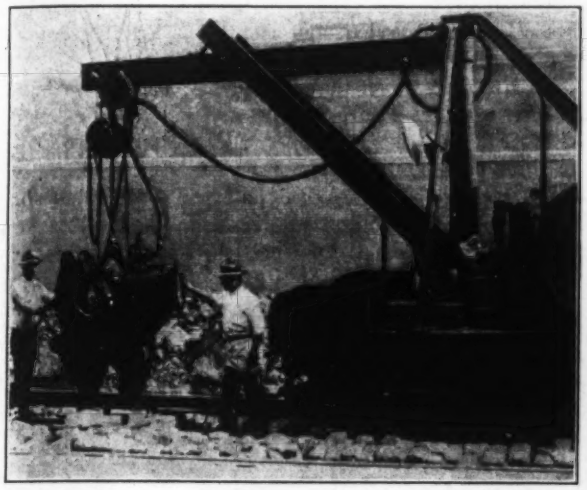


FIG. 1. RIVETING RAIL JOINTS, ST. LOUIS TRACK RECONSTRUCTION

The Nichol rail joint was used. It consisted of a pair of splice bars ½ in. thick and 32 in. long, riveted flat against the web of the rail with 1-in. rivets. The riveter is shown in Fig. 1. The rail ends were cleaned by sand-blasting before the bars were placed. These bars fit loosely around the base and under the head of the rail, and when they were in place molten zinc was poured to fill the spaces and make a solid joint.

The screw spikes were designed and made especially for this railway, and it requires between three and four times as much power to draw one from a cypress tie as it takes to draw the ordinary $\frac{5}{8} \times \frac{9}{16}$-in. hook-head spike. This holding power was shown at several points where screw spikes had been used on repair work, as the spikes pulled the cypress ties entirely out of the concrete when the old rail was lifted up with track jacks. The difficulty of locating the few screw spikes installed and the extra cost of removing the rail by unscrewing the spikes made it advantageous to pull up these ties. It was also considered advisable to remove these ties at this time, as for each tie there were two hook-head spike holes and two screw-spike holes. Very little damage was done to the concrete foundations by removing the ties in this manner.

The cypress ties thus removed were replaced with 7-ft. lengths of old 6-in. girder rail, which were attached to the track rails by ⅞-in. T-head bolts and rail clips. To expose the old cypress ties so that the new rails and tie plates could be laid, the rails were lifted by heavy track jacks and the old concrete was removed by concrete picks for a width of about 9 in. on each side of the old rails. Very little adzing was necessary to prepare the ties for the new tie-plates.

The new tracks were paved with granite blocks taken from the old tracks and redressed so as to give a very smooth surface. The size of the granite blocks was greatly reduced by the redressing. The blocks are held in place by a grouting of cement and sand, which also protects the edges of the blocks from breaking and becoming rounded, so that a very smooth pavement can be constructed and maintained.

Although weather conditions were unfavorable, approximately 6 mi. of track was reconstructed in five weeks. During this work the cars were removed from one track at a time and rerouted over other tracks. No cars were run over the track during the first eight days after the new concrete was placed along the rail. Fig. 2 shows the work in progress on one track, with the other track in service. The men are removing the old rails by means of track jacks, the rails being sawn apart between the welded joints.

FIG. 2. OLIVE ST. TRACK, ST. LOUIS, UNDER RECONSTRUCTION

One track is in service and the other is given over to the reconstruction work

The reconstruction work was under the direction of C. L. Hawkins, Engineer of Maintenance-of-Way of the United Railways Co.

The Hottest Region in the United States is Death Valley, in southeastern California, according to G. H. Wilson, district forecaster, San Francisco. The highest shade temperature ever recorded anywhere in the open air with standard instruments and under improved methods of exposure was recorded at Greenland Ranch, on the edge of Death Valley, on July 19, 1913, when the thermometer registered 134 deg. F. A remarkable record of high shade temperature occurred July 8 to 14 of that year, the daily maxima being as follows: 128 deg., 129, 134, 129, 130, 131, 127. During this period the temperature never fell below 85 deg. The Greenland Ranch of the Pacific Coast Borax Co. is located, very appropriately, on Furnace Creek. It is 178 ft. below sea level, but somewhat higher than the main floor of the valley. The shelter for the instruments of the coöperative Weather Bureau station is not exposed to the reflected heat from the desert.

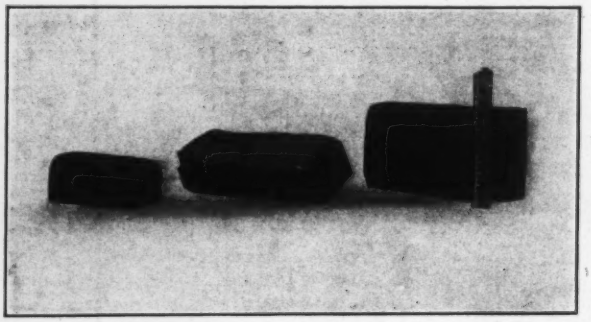
Field and Office

Brick Pavement Lasted 24 Yr.; New Pavement Also Brick

By H. K. Higgins*

The three bricks shown in the accompanying view were taken from Main St., Jackson, Mich., after a useful life of 24 yr. The largest brick was near the gutter at a point of minimum wear and shows the original glaze on all sides and corners. It has a vertical dimension of 4¼ in. The smaller ones were procured from near the middle of the street and are typical of a large fraction of the old bricks. The vertical dimension has been worn from 4¼ down to 1⅝ in.

The foundation for this pavement was a layer of inferior brick, laid flat, parallel to the axis of the street. A 1-in. sand cushion separated the two layers of brick. The filler was sand. Under the standard rattler test three



PAVING BRICK AFTER 24 YEARS' USE

runs with the surface or paving brick showed losses of 31.3%, 23.99% and 20.25%. As these tests were made on worn-out brick, it will be seen that the quality was good. The foundation course proved softer, losing 37%.

The new pavement which is being laid to replace the pictured bricks is also of brick, but of more modern pattern—the Hocking wire-cut lug.

The foundation is a concrete base 6 in. thick laid on the rolled subgrade and allowed to set hard. Portland cement with washed sand and gravel, 1:3:5, in a very wet mix, was used. A very solid base resulted. The concrete was mixed in a Koehring machine fitted with elevating hopper and bottom-dumping bucket on a horizontal boom. The hopper hoist and bucket traverse were fitted with automatic stops, which effectively prevented the usual overrun accidents.

The cushion was sand, 1½ in. deep, rolled and shaped to crown with a templet or "strike."

The bricks were laid, rolled by a 6-ton steam roller, culled, turned and rolled again.

The filler or grout was composed of equal parts cement and sand in a very liquid mix. It was mixed in a Hall mixer, two of which were constantly used. Contrary to the writer's expectation, the machine-mixed grout was in every way greatly superior to hand-mixed.

The prices bid on this work ranged from $1.94 up to $2.30 or more for brick, about 33% higher for creosoted lug block or sheet asphalt and about 12% less than brick for asphaltic concrete.

The street on which the old and new brick were laid is 62 ft. wide from curb to curb and half a mile long. On it is a double-track street railway, with two Y's and three branch-offs. The 100-lb. Am. Soc. C. E. rails of this track are laid on oak ties on an 8-in. concrete slab. The cars of the four interurban lines using the tracks were run during the whole repaving job, with never more than a few minutes' delay.

The contractor for the repaving work was W. H. Ryan, Lansing, Mich. The writer was in direct charge of the new work under City Engineer A. W. D. Hall and City Manager G. C. Cummin.

*209 McBride St., Jackson, Mich.

Trench Spoil Moved Cheaply by Tractor-Trailer Trains

Handling excavated material by small tractor and trailer trains was a feature of the recent construction of a large trench for a pipe subway at the Chicago Stock Yards. This method utilized the equipment of tractors and small trailer carts employed in conveying manure, supplies, etc. The tractors also haul wagons, as well as the small carts. The trench was 2,500 ft. long, 6 ft. wide and averaged 7 ft. in depth. It will contain a 15-in. steam main, a 6-in. return pipe and 20 conduits for electric power and telephone lines.

Cars Lowered Into Trench

The excavation was done by hand, owing to the numerous railway tracks crossing the trench. For the upper part the material was shoveled into the carts on the surface, but as the trench got deeper the carts were picked

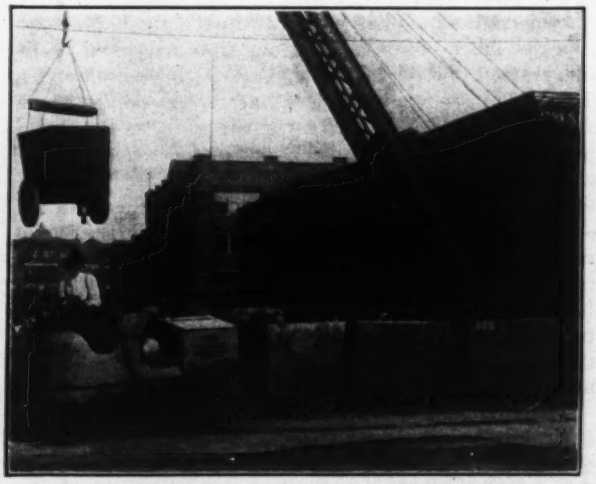


FIG. 1. REMOVING MATERIAL FROM A TRENCH BY TRACTOR AND CART-TRAIN

The crane handles the carts in and out of the trench

up by a locomotive crane and lowered into the trench. The loaded cars were hoisted out and placed in the street in the same way. Steel sheetpiling was driven to hold the sides of the excavation. Fig. 1 shows a tractor and train, with one of the carts being hoisted by the crane. The cart is held in wire slings, with plank stretchers.

The carts are of wood, with a capacity of 1.2 cu.yd., mounted on two side wheels and a small caster wheel under the front end. All the wheels have roller bearings. Very little load comes on the casters, and with carts in trains these small wheels are largely clear of the ground. About 500 of these carts are in use at the stockyards. For the trench work, trains of 10 carts (12 cu.yd.) were employed, hauled by gasoline tractors. Special triangular chain couplings are used, which insure accurate tracking, so that the trailers pass curves and turn sharp 90° corners without difficulty, or even make double right-angle turns. The three-wheel gasoline tractors weigh about 5,800 lb.

Dumping Machine Empties the Carts

The excavated material was used to fill low ground at the yards, and a dumping machine was built to handle the carts. This is shown in Fig. 2. It consists of a timber tower with a tilting platform at the base. Cables hitched to the free end of the platform are led to overhead blocks and thence to an electric hoist at the side of the tower. The machine can propel itself on planks as the filling advances. Plank runways are laid where the trailer trains run on soft ground.

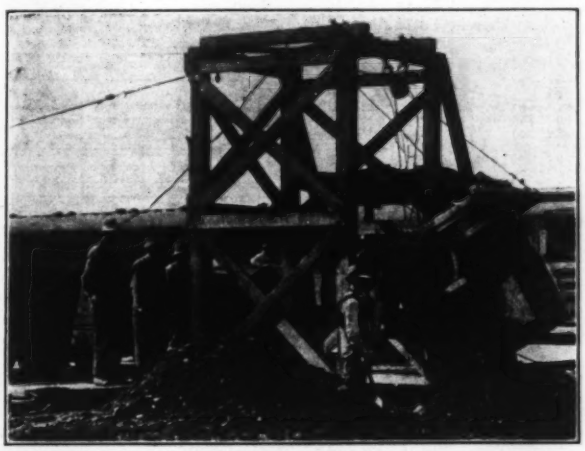


FIG. 2. ELECTRICALLY OPERATED DUMPING TOWER

The tractor on delivering a loaded train at the dump picked up an empty train for return. The men at the dump backed each cart in turn onto the platform, two pairs of angle irons forming guide grooves for the wheels. The rear end of the cart ran against a stop, and horizontal angles projecting over the wheels held it in place. The platform was then tilted by the cables, the arrangement being such that with heavy or sticky material the cart could be completely inverted, while the platform could be jarred to shake all material out of the cart.

Speed and Cheapness the Features

Rapid removal of the excavated material was necessary, as much of the work was in Exchange Ave., a main thoroughfare having very heavy traffic. With wagons and teams the progress would have been slow because of interference with traffic. The following comparative estimate of cost of hauling the material by tractors and trailers and by teams on another similar piece of work (4,000 cu.yd.) was prepared by R. L. Vaniman, the engineer in charge:

There were 270 cu.yd. of material moved daily. Nine wagons and teams were required, each hauling loads of 2 cu.yd. and making 15 trips per day. At $5.50 each, the total daily cost for hauling was $49.50, or 18.3c. per cu.yd. One tractor with a driver and helper cost about $12 per day (including wages, gasoline, oil and allowance for depreciation, interest and machine maintenance). By this method the cost per cubic yard was only 4.5c., a saving of 13.8c.

The trench work described in the foregoing was done by day labor under the direction of George W. Hegel, Engineer for the Union Stock Yards and Transit Co. The tractors are of the Bulley type (of which five are in regular use at the yards), built by the Mercury Manufacturing Co., of Chicago. The same company designed the dumping plant and the couplings for the carts.

Chicago & Northwestern Ry. Valuation Work

The roads of the Northwestern Railway System, consisting of the Chicago & Northwestern Ry. (and its subsidiary lines) and the Chicago, St. Paul, Minneapolis & Omaha Ry., are now actively engaged in the valuation of their property. In compliance with the orders issued by the Interstate Commerce Commission, and in anticipation of its inspections, the Northwestern System is conducting field surveys and investigating its records. It is also collecting and compiling as complete a statement as it is possible to make from these sources of the extent, character, cost, etc., of its physical property and the way in which it was constructed. The work is taken up by states and divisions, and the plan of procedure is to complete entirely a section of its road at a time. The valuation work is under the control of a Valuation Committee on each of the two roads.

Fieldwork for Valuation

The engineering features of the valuation work on both roads are under the direction of George W. Hand, Valuation Engineer. The force engaged in the work consists of 60 men on the Chicago & Northwestern Ry. and 18 on the Chicago, St. Paul, Minneapolis & Omaha. There are three parties in the field—two on the former and one on the latter road. Each field party is in the charge of an assistant engineer who has had several years' experience in responsible charge of construction and maintenance work. He is required to examine personally the character of the materials of which the road is constructed and to study and record all the conditions which would have effect in determining the cost of construction.

Under each assistant engineer there are three instrumentmen. One of these carries on the work of chaining the track and inventorying the main-line items (including rails, track, etc.). He is assisted by three helpers, recorder, rodman and tapeman. Another carries on the level work and is assisted by two helpers, rodman and tapeman. The third inventories the property at station grounds, consisting of buildings and sidings, and he is assisted by two helpers, rodman and tapeman.

A complete set of levels is being run, so that the company will be able to make a system of profiles of its entire lines, all of which will be referred to the same datum. For the purpose of computing grading quantities, or verifying original records, cross-sections are taken at all points where cross-sections could not be constructed from information already available. A complete inventory of all materials, such as rails, ties, fences, buildings, bridges and the like, is made as the survey progresses. The location of land lines is ascertained or verified where already a matter of record. Special effort is made to develop all visible evidences of hidden quantities.

The original chaining is followed as far as possible, so as to perpetuate the relation between existing records and the present condition. Another purpose is to show comprehensively the relation of the property as originally constructed to the present property, which has been affected by changes of alignment, reduction of curvature, grade changes and all the other modifications which have taken place since the road was first built.

On the Chicago & Northwestern Ry. an inspection of interlocking and signal apparatus is being made by a special and independent party, although certain information relative to the location of the signal apparatus is taken by the regular chaining and inventorying party. On the Chicago, St. Paul, Minneapolis & Omaha Ry. all this information is taken by the main-line inventory party, in which there is an extra man who is especially assigned to inventorying the signal apparatus.

MAIN TRACK—1—TIES. Division NORTHERN IOWA File No. 2-23 6-1

Station LINN GROVE Year Reported 1914 Date Compl. 1912 Order No. G. M. 18042
Sub-Division 21 Vol. and Page 2-372 Date Insp. AUG. 1913 Est. No.
Section 2
Remarks: Use separate card for each track.

Beginning	Ending	Lin. Feet Track	Lin. Ft. Switches	Lin. Ft. Bridges	Lin. Feet Track Ties	Tang. or Curve	No. Ties Per 100 Ft.	Kind	Total Number	Kegs Spikes
9154-63	9160-96	754	121		633	Tang.	56	Cedar	354	5.00
9160-96	9163-14	97		91	6	"	56	"	4	.99
MILE 174										
9163-14	9164-00	86			86	Tang.	54	Cedar	46	.51
9164-00	9169-65	565			565	Curve	28	Oak	158	1.76

MAIN LINE ROADBED—2. Division EASTERN File No. 6-7 3-2

Station BRAINARD Year Reported 1909-14
Sub-Division 10 . Sec. 8 Vol. and Page 1-311 3-225
Remarks: No. Tracks 1
Width Roadbed—Cuts 24'
" " —Fills 16'

CUTS AND FILLS Beginning	Ending	Roadbed, Highway, Ditch, Etc.	Embankment Cu. Yds.	CUBIC YARDS EXCAVATION Earth	Loose Rock	Solid Rock	Cubic yards Overhaul
1831-55	1832-00	R. B.	70				
1842-02	1981-56	R. B.	57494				
1856-00	1866-25	Channel Change		1667			
1877-25		Hy. Xing	142				
1981-56	1995-62	R. B.		6577	255	36	
1991-50	1977-70	Overhaul					22000
1991-50	2004-50	"					4000
1981-56	1995-62	Ditch		55			

MAIN TRACK—3—RAIL. DIVISION SIOUX CITY File No. 1-5 8-2

Station STRATFORD Year Reported 1913 Date Compl. 1910 Order No. V.P. 741
Subdivision 24 Vol. and Page 1-278 Date Insp. July 1913 Est. No.
Section 5
Remarks: If more than one track use a card for each track, and state which track.

Beginning	Ending	Wt. Rail	Rail Lgth	Date Laid	Lin. Ft. Track	ANGLE BARS No. Pairs	ANGLE BARS No. Bars	No. Base Plates	No. Tie Plates	No. Rail Braces	Anti-Rail Creepers
4536-90	4537-08	60#	30'	1892	18	1	4				
4537-08	4561-48	72#	30'	1904	2440	166	4	166	1237	133	20
MILE 87											
4561-48	4571-00	80#	30'	1908	952	65	4	65	427	65	
4571-00	4572-00	80#	30'	1908	22	294	4	294	2238	(Equation)	158
4572-00	4614-87	80#	30'	1908	4287						

FIG. 1. MAIN-TRACK VALUATION-RECORD INDEX CARDS; CHICAGO & NORTHWESTERN RY.

Only the headings and first entries of the cards are shown. Each card

Camp Trains and Headquarters

Each field party is housed and boarded in a camp train consisting of two cars—a diner and a sleeper. A cook and a helper are in charge of each camp outfit. The cars are hauled from place to place in passenger trains and set out on sidings and at stations convenient to the work. Supplies are obtained from Chicago and also from local sources. Such food supplies as can be kept on hand in bulk are furnished from Chicago; and such foodstuffs as milk, eggs, fresh fruits and vegetables are obtained from the nearest local source of supply. Ice and fuel are supplied from the most available source.

The diner is a made-over dining-car. The original dining room is divided into three parts. The end next to the kitchen is used for the dining-room and in the middle of the car a room is partitioned off for a sleeping room for the cook and helper. The remainder of the car is used as a field office for the assistant engineer. The sleeping-car is a made-over mail car. The middle is used for the sleeping room, which contains sanitary steel cots for the accommodation of 12 persons. There is a dressing-room at one end of the car, with a toilet and washroom adjacent. The other end of the car is used as an office and living room. Both cars have stoves and heaters and the usual steam coils for use when the cars are coupled to trains. The cars are lighted by oil lamps.

Field Books and Office Records

In this survey ordinary field books are used, no loose-leaf books being employed. The field books are made up in sets, so that each set forms a complete record of existing conditions. One book contains the record of the chaining and location of main-line items; others contain the records of bridges, signals, sidings and buildings. All books are properly cross-referenced and arranged so that when future changes are made additional notes therefor can be taken and the books kept intact.

In the office, maps and profiles are being made new, or existing maps and profiles are being corrected where possible from these field notes. The information contained in the field books is also collected and entered on a comprehensive card-index system of records (see Figs. 1 and 2). This system serves not only for the valuation work, but for a permanent record for the railway company's general purposes. Existing maps and profiles that are drawn to proper scale and are capable of being reproduced are corrected and lithographed. Otherwise new maps and profiles are made.

SIDINGS. #2 Division WEST IOWA File No. 1-139 19 -0

Station COUNCIL BLUFFS Year Reported 1907-15 Date Compl. 1914 Order No. GMO. 1332
Sub-Division 15 Vol. and Page 1-235 4-55 Date Insp. NOV. 1914 Est. No.
Section 22 Map Corrected 1915 Total Length 3067'

REMARKS: 0-00 = 31-19 on Track # 1
30-87 = 0-00 of Track # 4

TRACK From	To	Wt.	Lineal Ft.	No. Prs. A. B.	No. B. P.	Rail Braces	Tie Plates	BOLTS Size	No. Kegs	Nut Locks, No. Boxes	Spikes, No. Kegs
0-00	7-50	80#	750	47-26"	47	35		7/8"	1.923	.327	22.15
7-50	19-70	72#	1220	83-26"	83		435	3/4"	1.911	.483	
19-70	23-50	60#	380	28-24"		67	138	TIES			
23-50	25-00	72#	150	10-26"	10			Kind	Ft. Trk.	Spacing	No.
25-00	27-90	80#	290	18-26"	18		98	Cedar	2066	651100'	1733
27-90	30-67'	90#	277	17-26"	17	42	145				
								Switch	150		98
								2 Sets #8 = 4104 Ft. B.M.			

GRADING Items	Amount	FROGS AND SWITCHES Stand	Switch	Frog No.	Kind	Wt.	BALLAST Kind	Lin. Ft.	Depth	Width
Earth Excav.		Odenkirk	Split	#8	Rigid	80#	Gravel	3067	12"	10'
S. Rock "		#		#8	#	90#				
L. " "							2454 Cubic Yards			
Earth Emb'k.	1735	2 Switch Lamps								
Overhaul										

CLEARING Acres	GRUBBING Sq. Rods	RAILROAD CROSSINGS Angle	Kind	Length	No.	Wt.	Derails	Bumping Post
		65°		13'3"	1	72#	1-Hayes P.Con.	

BRIDGES. Division MINNESOTA Bridge No. 237 File No. 8-25 13

Station MANKATO Year Reported 1914 Date Compl. Sept. 1913 Order No. GMO. 12768
Sub-Division 12 Vol. and Page 3-22 Date Insp. June 1914 Est. No.
Section 25 Map Corrected 1915
REMARKS: Minnesota River DRAWING NUMBERS.

Location	Type	No. Spans	Total Length	Height	Grade + or −	Alignment	No. Tracks	Loading Specification	
1853-72	T. R. T.	2	363'6"	26'	0.00	Tang.	1	Coopers	E-55
	D. P. G.	2							

Kind of Spans	Length of Span	No. of Spans	Total Weight	No. of Panels	Floor Beams Kind	Floor Beams Size	STRINGERS No.	STRINGERS Kind	STRINGERS Size	Date Built	Kind of Floor
T.R.S.	121'6"	2	600657#								
D.P.G.	60'0"	2	117894#		Standard		1910	Type Deck		1913	Open

ABUTMENTS Piling, Lin. Ft.	Grillage, Ft. B. M.	Ht.	Kind	Cubic Yards	Date Built	No.	PIERS Ht.	Kind	Cu. Yds.	Piling	Grillage
1043		19'	Masonry	537	1913	2	19'	Concrete	354	787	
			Concrete	75							

FIG. 2. VALUATION-RECORD INDEX CARD FOR SIDINGS AND BRIDGES; CHICAGO & NORTHWESTERN RY.

is 5x8 in. The first two columns give the chaining, showing the location

Copies of existing maps are furnished to the field parties, together with copies of the standards required, so that they can readily see what additional information is necessary to make the maps and profiles adequate for the purpose, and also check them.

While all this valuation work is independent of the ordinary work of the engineering department, every effort is being made to adapt as far as possible the information thus obtained to the general purposes of the department. Thus, the plans and profiles are made in continuous rolls for filing as permanent records, although they are also prepared for reproduction in sheets.

Panama-Pacific Wells Sand Up; How Trouble Was Cured

Five 70- to 87-ft. wells were drilled to provide adequate water-supply for the Panama-Pacific International Exposition. These were in addition to an infiltration sump which yielded 350,000 gal. per day. This sump, located in Golden Gate Park, had been so expensive to construct that the well-sinking was decided upon, in spite of the fact that earlier wells in this same territory had been abandoned on account of inability to keep out sand.

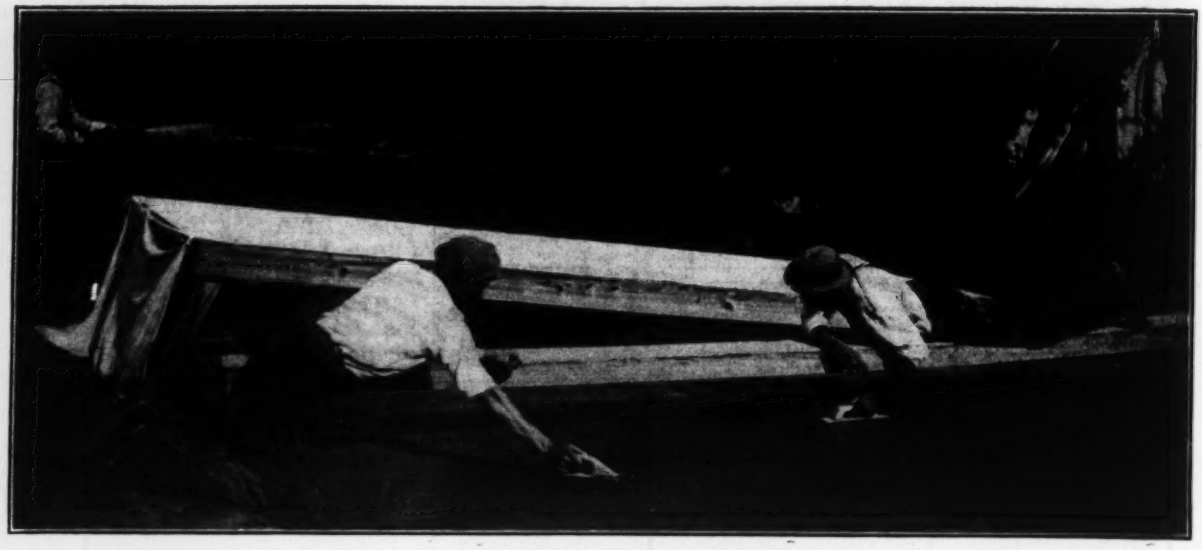
In sinking these five wells there were employed a 20-in. outside casing and an inside casing 16 in. in diameter. Both casings were perforated with slots having $\frac{1}{16}$-in. openings. The annular space between casings was filled with gravel ranging in size from rice to pea. The material encountered was a fine beach sand having an effective size of 0.18 mm. and a uniformity coefficient of 1.55. The total yield was expected to be 650,000 gal. per day for the five wells. This work is described in the October *Journal* of the American Society of Mechanical Engineers.

The first, or trial, well was very successful and on the strength of this four other wells were drilled. These gave trouble from the start. All the wells were of identical construction, were within an area of 650 ft. square and penetrated exactly the same kind of soil. The pumps used were vertical three-stage centrifugal pumps, belt-driven by 20-hp. motors and operated at 1,400 r.p.m. against a 75-ft. head. A foot valve was placed below the pump at first, but it caused the pump to choke with sand and was therefore discarded and a check valve placed in the discharge line from the pump. Each of the four wells in turn started to sand up as soon as any considerable amount of water was pumped, making it necessary to withdraw the pump and clear the well of sand.

The pumps were supposed to be adapted for handling water containing sand, but the bronze bearing bushings in some instances were cut out after one day's operation. To obviate this, the tubes inclosing the shafting were discarded and leather rings placed above and below each bushing. They were securely fastened to the bushings and fitted snugly on the shafting. By operating the pumps at 60 to 100 gal. per min. continuous flow could be obtained, but a large amount of sand would be discharged, the wells speedily choking. To avoid the expense and delay incident to removing the pumps and sand-bailing the wells an air ejector was made which could be lowered into a well without disturbing the pump. By this means 50 ft. of sand could be taken out in 3 hr.; but the removal of such large quantities soon caused the ground around the casing to cave, resulting in disturbance to foundations in the vicinity.

Cause of Trouble and the Remedy

The failure of the wells to work satisfactorily was laid to the size of gravel placed between the outside and inside casings. The remedy, therefore, was to find and use a suitable material that would keep the sand out of the well and at the same time let the water flow through freely. Tests resulted in the selection of a naturally graded beach sand having an effective size of 0.42 mm. and a uniformity coefficient of 2.18. With perforations of $\frac{1}{32}$ in. in width in the inside casing, the fine material from the



CANVAS-COVERED FRAMES PLACED OVER FRESH CONCRETE OF COLEMAN DU PONT ROAD

wells would be held back even when the velocity through the perforations was as high as 0.75 ft. per sec.

A sixth well was sunk, using an ejector instead of a well-drillers, standard equipment. Five days were required to complete the well to a depth of 60 ft. It developed on test a capacity of 200 gal. per min., and discharged no sand. The outer casing was 22 in. in diameter, of No. 12 gage steel, with collar joints, and perforated with slots $\frac{1}{16}$ in. wide by $1\frac{3}{4}$ in. long. The inner casing was 16 in. in diameter, with perforations $\frac{1}{32}$ in. wide (area of perforations estimated at 0.0329 sq.ft. per lin.ft. of pipe). Perforated casing was used throughout, except for the bottom section and the upper five sections. The sand used in the jacket was the grade determined by test to be the best. Instead of drilling additional wells of this type it was decided to reconstruct the other wells (except No. 1) so that they would develop their full capacity.

The inside casing in the four wells could not be removed, but the diameter of the deep-well pumps allowed a 13½-in. casing to be placed inside the well. One of the wells was equipped thus and the space between the inside casing and the middle one was filled with the same grade material as used in No. 6 well. The installation of the third casing required only about 8 hr. work. Under test the remodeled well operated continuously at a rate of 243 gal. per min., and gave no sand. The other three were then reconstructed in the same way.

Protecting Fresh Road Concrete from Sun in Delaware

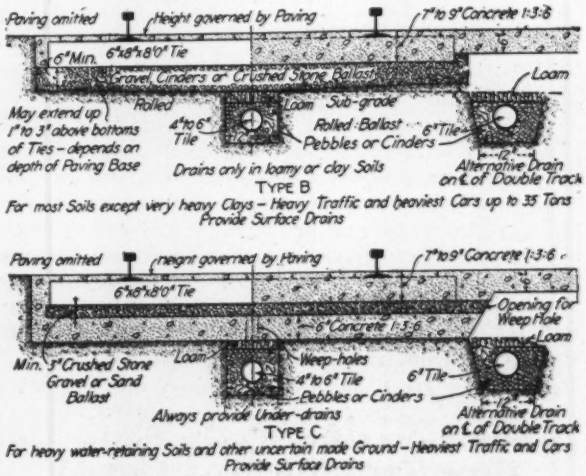
The Coleman du Pont Road in Delaware is being constructed under strong specifications and rigid engineering inspection and supervision. One of the requirements is that the concrete be protected from the sun, immediately after placing, by canvas-covered frames. These are 10x15 ft. and are placed at least 1 ft. above the concrete and kept wet. The frames are removed on the following day and the concrete is covered with 2 in. of earth, kept wet 14 days, and traffic kept off 30 days.

The concrete is a 1:2:4 mix, with 10% (by volume) of hydrate of lime. Mixing must continue for at least 1½ min. at a minimum speed of 15 r.p.m. The concrete is laid 5 in. thick at the sides and 7 in. thick at the crown. Immediately after finishing, the canvas frames are placed.

Charles M. Upham is Chief Engineer of the Coleman du Pont Road, Inc., Georgetown, Del.

Recommended Street-Railway Track Construction

Two types of street-railway track construction in paved streets were presented as "recommended designs" by the Committee on Way Matters of the American Electric Railway Engineering Association, at the recent convention


Paving omitted
Height governed by Paving
7" to 9" Concrete 1:3:6
6" Min.
6"x8"x8'0" Tie
Gravel, Cinders or Crushed Stone Ballast
Loam
Rolled
Loam
Sub-grade
May extend up 1" to 3" above bottoms of Ties – depends on depth of Paving Base
4" to 6" Tile
Rolled Ballast
6" Tile
Pebbles or Cinders
12"
Drains only in loamy or clay Soils
Alternative Drain on ℄ of Double Track
TYPE B
For most Soils except very heavy Clays – Heavy Traffic and heaviest Cars up to 35 Tons
Provide Surface Drains
Paving omitted
Height governed by Paving
7" to 9" Concrete 1:3:6
6"x8"x8'0" Tie
Opening for Weep Hole
6" Concrete 1:3:6
Loam
Min. 3" Crushed Stone Gravel or Sand Ballast
Loam
Weep-holes
4" to 6" Tile
6" Tile
Pebbles or Cinders
12"
Always provide Under-drains
Alternative Drain on ℄ of Double Track
TYPE C
For heavy water-retaining Soils and other uncertain made Ground – Heaviest Traffic and Cars
Provide Surface Drains

APPROVED TYPES OF CITY-TRACK CONSTRUCTION

(Oct. 4-8, 1915). These are shown in the accompanying cross-sections. They are known as Types B and C, corresponding closely to the Types B and C recommended by the same committee in 1914 (see *Engineering News*, Nov. 26, 1914, p. 1079, for sketches). The old Type A was eliminated as it was decided that there were too few localities where it could be successfully used. Old Type D was eliminated in favor of Type C.

Tests Fail to Show Cause of Retarded Set of Concrete

By Alfred W. Hartman*

During the construction of a 57-in. concrete pipe drain, one of the main trunks of the Baltimore storm-water drainage system, a 30-ft. section of a 4-in. concrete cradle, placed in advance of the laying of the pipe, failed to harden in 96 hr., while similar concrete made from the same materials placed the day before in the same trench, but on different soil, hardened in the usual manner. The foundation soil under the section that failed to harden consisted of white clay, containing a very large percentage of mica in a finely divided condition, and was quite wet. The soil under the section placed on the previous day was red clay. As the weather conditions at the time of placing both sections were practically the same, it was thought there might be something in the underlying soil that had affected the action of the cement in setting.

The aggregate used in the concrete was clean Chesapeake Bay gravel, which has been used with good results in all of the sewer construction; so this was eliminated as a possible cause of the trouble.

In effort to discover the cause of the trouble, briquettes were made with the sand used on the work and the same cement, which had previously been tested by the municipal laboratory. The briquettes were heavily coated with wet mica clay and with wet red clay, stored in moist air and the seven-day tensile strength determined on a number of specimens.

Briquettes were also made with the sand used on the work, with standard sand and without the addition of clays. These were stored under water and the seven-day tensile strength determined. The time of set of the cement neat and the same cement heavily coated with wet mica clay was also determined.

A sample of the concrete which failed to harden in the trench was brought to the laboratory, to see what effect the indoor temperature would have upon it. In 48 hr. it had set hard.

The results of the tests herewith given in tabular form show no action of the white and red clays on the mortar. The time of set of the neat cement was slowed slightly by heavily covering it with the wet mica clay, but this was to be expected under the conditions. The temperature of the air on the days when the concrete bottoms were placed was about 55° F.

TABLE SHOWING EFFECT OF COATING CEMENT BRIQUETTES WITH MICA CLAY

(Tensile Strength in Pounds per Square Inch)

Standard Sand 1 : 3, Stored Under Water 7 Days	Arundel Sand 1 : 3, Tidewater Cement, Lot No. 3,277 7 Days
275	265
280	270
285	300
280	275

Arundel Sand Covered with Red Clay 1 : 3, Stored in Moist Air 7 Days	Arundel Sand Covered with Mica Clay 1 : 3, 7 Days
275	275
285	295
300	300
287	290

Neat Cement

Time of set, regular	Time of set covered with mica clay, wet
Initial—4 hr., 10 min.	Initial—5 hr., 5 min.
Final—6 hr., 10 min.	Initial—7 hr., 5 min.

Judging from the setting up of the concrete in the laboratory, there is no question that this concrete would have finally hardened in the trench; but as the contractor was anxious to proceed with the laying of the pipe, which required a hardened invert, the slow-setting concrete was torn out and a richer mix substituted. This mix hardened in the usual manner. The retarded set may have been caused by the lean mixture (1:3:7) and an excess of mixing water.

Calvin W. Hendrick is Chief Engineer of the Baltimore Sewerage Commission and George J. Armeling is Engineer of Tests.

*Division Engineer, Sewerage Commission, Baltimore, Md.

Repairing a Split Water Main

A longitudinal crack in a 12-in. cast-iron water main, which was too long to be repaired in the customary way, by fitting a split sleeve over the leak, was satisfactorily stopped in the manner shown in the accompanying views. The main supplies a section of Concord, N. H., and the inconvenience of shutting off the water for a considerable time, as well as unnecessary expense, was to be avoided. An iron casting about 3 ft. 6 in. by 1 in. thick, curved to conform to the outside diameter of the pipe, was obtained from a local foundry. The wrought-iron rods are about ¾ in. diameter and the yoke plates are about ⅝ in. thick. A ½-in. lead gasket, the same length and width as the casting, was placed between pipe and casting and pushed over the crack; then the nuts were tightened and the joint was calked. It was not necessary to shut off the water from the main, as water from the leak could be cared for by trench pumps.

LEAD-GASKETED PATCH ON 12-IN. WATER MAIN

The superintendent of the water-works of Concord is Percy R. Sanders.

Testing Water-Main Flow

By R. C. Hardman*

The carrying capacity of cast-iron water mains in actual use in Denver, Colo., was tested during the winter of 1913-14 by means of pressure-recording gages and water-meters.

The mains tested were selected for their accessibility, freedom from pump pulsations and the possibility of cutting out the section under test without interrupting service beyond the section and on the connecting gridirons. The tests were conducted after midnight, to minimize the effect of service drafts. The test sections were in general 1,000 ft. in length. Bristol recording gages were installed on taps at each end of the test section, with a third gage approximately midway between the two to serve as a check. The gages, inclosed in large wooden boxes, were supported upon low trestles and connected with the corporation cock by means of a ½-in. rubber hose with the necessary stop and blow-off cocks. As the tests were all made in freezing weather, provisions against freezing were made by placing a candle inside the gage box and immediately outside the main, between the corporation cock and rubber hose, by placing a short section of pipe in a small metal box heated by a gasoline blow torch.

The flow was measured by a 6-in. meter, connected to the steamer nozzle of the first fire hydrant below the section under test. The meter was mounted on a low truck to facilitate moving.

The recording gages were so adjusted that the chart made one revolution per hour instead of the usual 24. As most of the tests consumed more than one hour, ink of a different color was used after one revolution of the chart to obviate any confusion of crossing lines.

TEST OF CARRYING CAPACITY OF 6-IN. CAST-IRON WATER MAIN, DENVER, COLO.

Time, P. M.	Flow, Gal. per Min.	Pressure-Gage Records, No. 1, Lb.	No. 2, Lb.	No. 3, Lb.	Diff. Nos. 1-3, Lb.	Diff. Nos. 1-3, Ft.	Diff. in Elev. by Level	Friction Loss, In. 842 Ft.	Friction Loss, In. 1,000 Ft.
9:44	Static	54.8	56.8	60.5					
9:48	112.5*	52.0	54.0	57.5	—5.5	—12.702	13.200	0.498	0.594
9:53	183.5†	49.7	51.0	54.0	—4.3	—9.929	13.200	3.271	3.885
10:00	297.0‡	42.8	42.8	45.0	—2.2	—5.081	13.200	8.119	9.643
10:07	364.0	36.6	35.8	36.8	—0.2	—0.462	13.200	12.738	15.128
10:16	464.0	29.0	26.5	26.8	2.2	5.081	13.200	18.281	21.711
10:23	519.0	22.6	18.9	18.5	4.1	9.469	13.200	22.669	27.350
	Static	55.5	57.4	61.1					

Location of meter—At end of line.
Kind of meter—Crown.
Location of gages—No. 1, on tap 5 ft. west of Broadway; No. 2, on tap 522 ft. west of Broadway; No. 3, on tap 847 ft. west of Broadway; 842 ft. between No. 1 and No. 3.
Distance between gage No. 3 and draft hydrant—100 ft.
Date—Jan. 8, 1914.
Party—Allen, Hardman, Flood, Amsley, Gayton.
* Plus 3 gal. per min. for leakage at hydrant.
† Plus 4 gal per min. for leakage at hydrant.
‡ Plus 5 gal. per min. for leakage at hydrant.

In making the tests, all necessary valves on the main line and gridirons were closed, the gages were connected to the taps and the meter was connected to the hydrant. The static pressure on the main was then recorded on the gage charts for a period of about 5 min. The hydrant was then opened and the meter flow recorded for a period of 5 min. A large number of such meter readings was made for various conditions of flow—from about 75 or 100 gal. per min. up to a full hydrant flow. The meter readings were made by two observers with a stopwatch which had been synchronized with the gage clocks. At the end of the test the gages recorded static pressure for another 5-min. period.

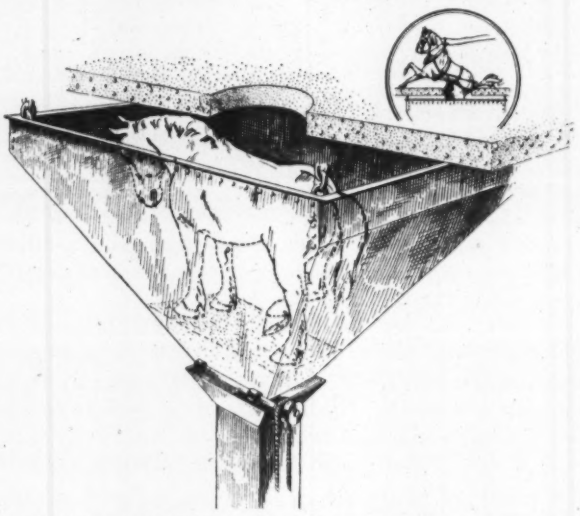
By this means not only the carrying capacity of the main was determined, but also values of the coefficient C for the varying values of Q and s could be deduced.

A typical test record is shown by the accompanying table. This was the only test section other than 1,000 ft. in length; but friction losses are based upon the standard section.

*307 Cheyenne Boulevard, Colorado Springs, Colo.

NOTES

Horse Falls Through Coal Hole—A problem was presented to engineers of St. Paul, Minn., on Sept. 28, when they were called upon to rescue a draft horse which had fallen through a 32-in. coal hole into a hopper. The coal hopper was suspended from the basement ceiling of the Merchants Bank Building



THE COAL-HOLE EPISODE SKETCHED BY LOCAL ARTIST

Rescue was effected after 24 hr. by cutting out a section of reinforced-concrete floor 5½ ft. long by 3 ft. wide and lifting the horse out by means of an improvised derrick. The animal seemed not to have suffered any ill effects from his confinement or his passage through the 32-in. hole.

Distant Highway-Crossing Signals at several dangerous approaches have been used by the Southern Pacific Co., in Tropico, Calif. The scheme resembles standard practice of railway signaling in having "home" and "distant" indications. At the railway grade crossing is placed a regular warning signal of any approved electric-lamp type. A hundred feet or more back from the crossing is the new "distant" signal. The device comprises a 3-in. steel-pipe post supporting an 8-in. by 2½-ft. horizontal steel tube passing through a vertical 20-in. steel disk. The tube and the back of the disk are black; the front of the disk is red. The tube is parallel to the roadway and is open at the front only. Inside is a high-candlepower electric lamp with a reflector in back and a red lens in front. It is reported that the warning light is as plain in the daytime as at night—though the red disk alone gives an added caution signal.

ROAD DISTANT SIGNAL FOR RAILWAY CROSSING

Philadelphia Used Dynamite for Land Drainage—Dynamite for land drainage and mosquito extermination is thus described and commented on in the latest annual report of the Philadelphia Department of Public Works: "The use of dynamite for fighting the mosquito was successfully tried. It apparently is a splendid device wherever you have a large area covered by a shallow depth of water. In one location where we had this condition a hole 20 ft. deep was excavated by a single inexpensive charge of the explosive and the entire area drained into the hole." The water which stood in the sump so created was oiled for mosquito prevention.

Editorials

Improving the Constitution of the State of New York

Choosing a state engineer by popular vote will be done away with and numerous other noteworthy reforms will be effected if the voters of New York adopt the constitutional amendments which will come before them on Nov. 2.

Among the other reforms included in the proposed amendments it is pertinent to mention here the shortening of the ballot in other ways than the one named; a systematic reorganization of the whole administrative service of the state along relatively simple lines, the substitution of serial bonds for sinking funds and the limiting of all bonds to the life of the improvements, these changes being applicable to municipal as well as state bonds; a state budget, to be prepared by the Governor; a considerable degree of municipal home rule, and a slight loosening of the absurd restrictions which now render the vast forest reserves of the state of little use beyond saving them for posterity.

At present the state engineer and surveyor of New York is elected on the general state ticket with the Governor and five other officers. All told, the administrative affairs of the state are now scattered haphazard among 150 bureaus, commissions, boards and individual officers. There is much overlapping and duplication of work, besides no little conflict of authority. Such overlapping makes it difficult to place responsibility, and the mixed system of election and appointment to office, complicated further by gubernatorial appointment and senatorial confirmation, makes holding anyone to responsibility absolutely impossible.

This morass of doubt and despair would be largely removed by the adoption of the administrative scheme proposed in the constitutional amendments. Instead of seven officers elected by popular vote there would be only four—a half-way step to the ideal short ballot—and in place of 150 ill-assorted administrative departments there would be only 17, systematically planned. Moreover, most of the departments would be single-headed, and except for the two elected by popular vote these heads would be appointed by the Governor, without confirmation by the legislature. Three departments, possessing both legislative and executive functions, would be composed of from 3 to 9 members—appointed by the Governor but confirmed by the state. A fourth department, also having legislative as well as executive functions, would be single-headed or not, in the discretion of the legislature. A single department out of the entire 17 is free of control by either the Governor or the legislature. This is the Department of Education, which remains under a Board of Regents, created in 1784. All heads of single-headed departments and the members of at least the two most important commissions would be subject alike to removal by the Governor or by a two-thirds vote of the senate or by impeachment.

The Governor's large power of appointment and removal makes one person ultimately responsible for nearly the whole administrative as distinct from the legislative and judicial work of the state. This accords with the business and efficiency theory of government. The power of the senate to remove executive officers and the power of the legislature to impeach tend to lessen this single responsibility, but it may be a necessary concession to the opponents of "one-man" control.

The 17 departments provided under the proposed new constitution are: Law, Finance, Accounts, Treasury, Taxation, State, Public Works, Health, Agriculture, Charities and Corrections, Banking, Insurance, Labor and Industry, Education, Public Utilities, Conservation, Civil Service. The heads of the first two departments (Attorney-General and Comptroller) are elected with the Governor and Attorney-General.

Chief interest centers in the Department of Public Works, the provision creating which states:

> (7) The head of the Department of Public Works shall be the superintendent of public works. He shall have the construction, care, maintenance and operation of the state's public works, including canals, highways and all public buildings not from time to time assigned by law to any other department, and shall provide for the needs of the several state departments in engineering and architecture.

It will be seen that this provision puts all the public works and buildings of the entire state, except as the legislature may otherwise dispose of buildings, under a single department. This will be welcomed by many engineers as a great step in advance. On its face the clause also puts all the engineering and architectural work of the state under this one department. Whether it really goes so far as to make it impossible for other departments to have engineering and architectural staffs of their own remains to be seen. Certainly the concentration of all engineering services in one department is, in so far as it does not weaken other departments, highly desirable.

The Department of Public Utilities stands next in interest, but requires only passing mention, because the status of the two existing commissions is unchanged, except that they are made creatures of the constitution instead of the legislature.

The Department of Conservation will exercise about, if not exactly, the same functions as the present Conservation Commission, which succeeded the earlier Water-Supply Commission and Forest, Fish and Game Commission. The new department would consist of nine commissioners, each from one of the nine judicial districts of the state, each to serve for nine years, and without compensation. This department is unique in respect of all four of the specifications in the foregoing sentence. It is charged "with the development and protection of the natural resources of the state," and particularly with the state forests and the encouragement of forestry, the "conservation, prevention of pollution, and regulation of the waters of the state"; and the protection of the forest preserve and reforesting, the building of fire trails and

of a single specified road, and the removal of dead timber; but none of the latter may be sold, and no other improvement cutting is permitted. Even these slight steps toward a real forest policy beyond the preservation of the natural wilds are a cause for thankfulness.

No qualifications are stated for appointees to any of the administrative state offices named in the constitutional amendments. Engineers thus fare in this respect neither better nor worse than members of other professions. The legislature will have a free hand to specify the professional or other qualifications of department heads, or to leave the Governor free in the matter.

As to the other features of the amendments mentioned in the opening paragraph of this article, it can only be said that they are in line with the accepted principles of good government and private business alike. Highly commendable is the restriction of the life of future bond issues, either state or municipal, to the life of the improvement for which they are to pay. The home-rule provisions will leave municipalities much freer than now to work out their own salvation, and by lessening the volume of local legislation will give the legislature more time than it now has to perfect important state policies.

Altogether, the provisions of the amendments which most affect engineers, directly and indirectly, are distinct steps in advance. Some of the engineers who devotedly sought to help shape the amendments will doubtless be disappointed with the small outcome of their efforts; but on the whole there is cause for thankfulness that so much was done toward putting a modern constitution before the voters of New York on Nov. 2.

A Lesson in Jitney Regulation

Commissions, municipalities, trolley companies and even prospective jitney-bus operators who are wrestling with the problem of regulating jitney transportation will be glad to know that the New York Public Service Commission, Second District, has established a precedent on which they may hang their practice. Some months ago the legislature provided that jitney-bus men, before starting operation, must obtain a "certificate of convenience and necessity" from the Public Service Commission. This dampened the enthusiasm of many, so that there has been only one case where formal application has been pushed to completion. In this instance one William M. Gray asked for leave to operate six routes in the suburban town of New Rochelle. The commission approved four of the six lines and disapproved of two. The case is so typical that the commission has taken the opportunity of expressing at some length the general principles on which it will judge such cases.

The opinion, written by Commissioner Emmet, states that it is the duty of the commission to protect established utilities from unnecessary competition, but that the public is entitled to some individual liberty in the choice of transportation, except where that choice would obviously lead to ruinous competition. Improvements in automobile construction and highway maintenance are recognized as stimulating the preference which persons residing at distances from a trolley line may have for motor-bus lines.

Applying these principles, the four routes authorized run on the same streets with street cars for only such short distances as are necessary to give the busses access to the railroad station; except for these approaches to the urban center, the lines in general are not parallel or close to the existing trolley lines. The two routes for which certificates were refused would have been parallel to and on the same streets with existing lines.

The commission compliments the city authorities and the applicant for the care of arranging their plans and safeguarding the public from erratic service. For instance, the franchise requires that the busses shall seat from 10 to 17 persons, shall be of the prepayment type, shall have pneumatic tires and shall be kept in good condition. The operator must provide seats for all passengers. Fare for a continuous ride is to be 5c. Children under five years old and policemen and firemen on duty must be carried free. Busses have to run on a 20-min. schedule from 6.30 a.m. to 1.30 p.m. The franchise expires in 10 years, and 3% of the gross earnings is to be paid to the city. The applicant has to give a bond for prompt payment of his obligations. Busses have to stop on signal at the near side of street crossing and conform to present and future traffic regulations.

Such conditions make bus lines really transportation systems, in contrast with the original jitneys, which gave only a precarious hack service. The old jitney operation was much cheaper of course, but at the expense of public safety and convenience. Under such regulation as seen in New York State the bus is little less than a trackless and trolleyless street car.

Something New in Street-Railway Terminals

One of the most novel and interesting structures erected in this country in recent years is the tramway terminal and office building of the Public Service Ry. in Newark, N. J. Even the fundamental idea of a street-railway terminal under the conditions which obtain in a strictly urban district is novel. Of course all through the Middle West interurban terminals on private property with loop tracks are common, and indeed they were the inspiration for the design which was worked out in Newark. Rapid-transit stations with distribution concourses either above or below the car tracks are not new. But the combination of these several elements now seen in Newark and in connection with a city traction system is striking and original.

All engineers who believe in the usefulness of a fresh viewpoint in the solution of a complicated engineering problem will be interested to realize that while the designing engineers were struggling with a complicated terminal trackage on one level, a lawyer—the president of the railway company—came along and suggested the three transportation floors that were finally employed. He also had a keen eye for business when he put the order departments of the allied gas and electric companies on the concourse, where they could alluringly display the apparatus employed in their services.

The structure itself is found to have very many interesting points of design—for instance, the subway-track floor system, which is carried on the main foundation piers, but is only loosely tied to the building columns. The elevated-track system is necessarily carried on the same columns which support the office structure. The entire foundations and all the subway and elevated ap-

proaches are incased in a continuous waterproof envelope to shut off ground water—and the engineers and contractors declare that the vast membrane is truly effective throughout its entire extent.

New York Grows in Importance

New York City, with its metropolitan district, has once again come into its own in the American Society of Civil Engineers. Last year, probably because of the emphasis in Pacific Coast activities, only one of the presidential and vice-presidential incumbents came from New York City. The candidates to be voted on in the coming election comprise a president from New York City, a vice-president from New York City and a vice-president from Troy, N. Y. So that, with the one holdover New York City vice-president, the metropolitan district (by stretching the boundaries up the Hudson to Troy) will have four of the five executive offices, to say nothing of the recurring secretary, the treasurer and six out of eighteen directors.

Undoubtedly this concentration is fortuitous—the result of a careful selection of the right man without regard to his location; but in view of some of the current complaints of metropolitan domination, it is at least unfortunate.

The multiplication of state utility-regulating commissions in a number of states has resulted in an apparent overlapping of the authority of some of these commissions. This is a condition which has been feared by many of the advocates of state regulation because of the opportunities it has offered for friction between the different commissions and for "passing-the-buck" contests—during which offenders against the spirit of the regulating acts are allowed to slip through without attention from any of the commissions. The neat way in which one such situation is being handled in Wisconsin should be broadly copied. The state laws of 1911 conferred on the Industrial Commission authority to establish an electrical safety code. The 1915 legislature empowered the Railroad Commission to enforce reasonable rules and standards and to require changes in construction and operation for public safety or service interference. The two commissions have combined their efforts, have formulated tentative standards of electrical construction and operation and have advertised a joint hearing. After the hearing the rules will be amended and jointly promulgated. Incidentally the safety rules are based on the tentative code of the United States Bureau of Standards and the interference rules embody the conclusions of a joint committee of various technical societies and the California Railroad Commission.

The Portland Harbor Bridge, described on another page of this issue, is in many ways a remarkable piece of work. It is not often that so many different and at the same time novel types of structure are included in one bridge. Offhand one would be apt to think that here was another of those all too numerous instances where the engineer has been dabbling in a variety of new and untried experiments, more to broaden his own experience than to solve most economically the problem in hand. A study of the structure, however, will convince such a critic that the conditions to be met in the three-quarter mile crossing were many and various, and that the most careful effort was made to meet each of the conditions with an economical and at the same time pleasing and safe structure. The resulting design, though consisting of a number of peculiarly individualistic parts, has in appearance a very satisfactory unity.

Letters to the Editor

Railway Engineer Wrestles with Road-Building Problems

Sir—The writer is interested in the letter of Professor Coghlan in *Engineering News* of Sept. 30, 1915, in which he intimates that the railway engineer is not likely to be successful as a builder of roads or highways. This interest arises because the writer's experience has been almost wholly on railway work, and having recently been elected a trustee of the village in which he resides, and promptly made the "Committee on Streets and Sewers," he found himself "up against" a practical proposition with which he had only a general acquaintance.

One of the first matters which came up for consideration was the type of surfacing to adopt for certain new roads. The proposed expenditures were well up toward $100,000 and there was little time for careful investigation. A hurried search of the available literature produced little of value as a guide in this particular case, and the opinions of several well-known experts were obtained by correspondence as a courtesy to the writer. These opinions were divided, however, though it is only fair to say that none of the gentlemen had been on the ground to see the actual conditions. They all agreed that good roads could be built by many different methods, if the methods were carefully and intelligently carried out—a maxim common to the whole art of engineering.

It seemed to the writer then—and this opinion has been confirmed by further investigation of the literature of road construction, by inspection of numerous roads and by talking with many engineers responsible for their construction and maintenance—that the art of highway building is to a considerable extent in an experimental state. There is certainly a lack of data to determine the true economy of any particular type of pavement, based on first cost, density of traffic and cost of maintenance.

The problem is by no means easy, as there are so many variables; but it seems to the writer that it will be solved in the first place by the application of "common sense," as are all engineering problems of this nature, aided later by properly kept and properly interpreted records, of the kind which railroad engineers have for many years

been accumulating in reference to railway location and construction. No one will deny that proper experience is a valuable asset, but it will hardly do to compare an intelligent, progressive, common-sense engineer who happens to have had experience in highway work with any other, be he a railroad engineer or not, who is merely technically educated and lacks the saving grace of common sense and broadness of vision, as do so many men in all professions and businesses.

Taking Professor Coghlan's illustration of the question of grades, there is probably as much dense ignorance of the economic value of grades among the average run of railway engineers as there is anywhere, and no one knows better than those who have studied this subject that many thousands of dollars have been wasted on grade revisions on railways. Railway engineers have learned that the electric motor can exert a tractive effort much above the normal for short periods, and therefore can surmount short stretches of steep gradient. It is not a long way from this to the realization that a horse might do the same thing; but there is an interesting problem in devising a form of pavement for steep gradients which will permit the horse to get a good foothold and smooth enough to reduce the rolling friction to a minimum.

As a student of highway problems, the writer has labored under the impression that his past experience on railroad work would not be a serious handicap. He hopes he will not be disillusioned. F. LAVIS.

50 Church St., New York, Oct. 2, 1915.

Curious Sewer Engineering

Sir—I inclose herewith a copy of what purports to be specifications for a sewerage system for a town in Arizona, which I will call Blank.

I have observed with interest the procedure in connection with this work from its inception, and it occurs to me that it is the engineers themselves who are responsible for a condition which tends, and is tending, to depreciate the engineering profession. In the first place, when a sewer system was considered, some four or five men—claiming to be engineers, all of them—were called upon to suggest to the Common Council the best plan for a sewerage system.

After listening to their arguments, a contract was awarded by the council to a Denver concern, which was to furnish plans and specifications, purchase the bonds and finally bid upon the actual work; further agreeing, if their bid was accepted, to make no charge for engineering services up to that time.

The council thought it best to hire someone to see that the Denver consulting engineers designed a proper system. Therefore, through influence or otherwise, it employed a man who is filling a position as water commissioner on an irrigation project in the vicinity of Blank (for which he is receiving a salary of $185 per month). He was unanimously made "city engineer," and since the plans and specifications—which I understand were unique—were then received, he began their modification to suit his own ideas of what they really should be—all this in connection with his other position previously mentioned.

After his revision of the Denver firm's plans and specifications to suit his own ideas, the Common Council decided that, since the original plans and specifications required modification, it could not accept them and therefore compromised with the Denver people by paying $400 or $500 for consulting-engineering services.

At this stage a committee of citizens appeared before the Common Council and insisted that the sewer be put in deep enough so that the basements in the business section at least could be drained, since the city engineer had decided that a surface system was all that would be required.

The writer was present at this conference and was particularly amused at the replies made by this city engineer to various questions put to him. In response to the question as to whether he had ever had any experience in the design of a sewer system or its installation prior to this time, he replied that he had not, but had seen several sewer systems. Notwithstanding his absolute lack of qualifications, he was retained upon a commission basis of some 5%, which, considering the estimated cost of the system ($80,000) amounts to $4,000, out of which he agreed to defray the expense of the Denver consulting engineer's services.

I have wondered whether the engineering profession is to blame for this condition. The writer, being engaged in other engineering work of an altogether different character, could not very well take an active part in the matter.

Blank is a very prosperous, growing town of some 3,500 inhabitants, its population having increased about 300% in the last four or five years. A READER.

Sept. 22, 1915.

More on New Orleans Storm

Sir—My attention has just been called to the article entitled "Engineering Aspects of New Orleans Hurricane," by Prof. W. H. P. Creighton, in your issue of Oct. 7, 1915, which I think conveys an idea probably not intended by its writer. He says: "Open sheds, car barns, and dock sheds suffered, but they were of flimsy construction and when lifted from the ground easily collapsed. Thus the Dumaine dock shed," etc.

The Dumaine shed was about 600 ft. long. The aggregate length of all the wharf sheds is more than 19,000 ft. The Dumaine shed was designed by the same standards as were all the other 18,400 ft. of sheds, all of which are still standing and all of which without doubt withstood approximately the same wind loads.

The Dumaine shed rested upon the last of the uncreosoted wharves which had been condemned some time since, and I am informed that some of the column footings had been disconnectetd from the floor of the wharf for the purpose of jacking up and shimming. This wharf showed signs of decay, and in addition to this weakness, the engineer of the Port Commission informs me that several vessels from the opposite side of the river were torn from their moorings and driven into this wharf by the force of the wind. He thinks the impact of these vessels was responsible for the collapse of the shed.

In the concluding paragraph of Professor Creighton's article he states that "no well-designed engineering structure received more than trivial damage," in which statement I agree, except that I claim the Dumaine shed to have been a "well-designed engineering structure" which failed, the failure being due to the causes above described. J. F. COLEMAN.

Hibernia Building, New Orleans, Oct. 15, 1915.

[In explanation of his original statement, Professor Creighton submits the following.—Editor.]

Sir—In my telegraphed report I endeavored to say as much as possible in a few words. Broad generalizations are liable to err in particular phases of certain elements.

The word flimsy was used in connection with structures carrying no load, as in effect they are shelters only. The necessary weight of material used in their construction is therefore a minimum. Carrying no loads and the weight of structural material used being a minimum, it is evident that they are weak in resisting upward pressure.

I agree with Mr. Coleman in believing the weight of structural-steel elements used in building the shed to be ample, as the destruction seems to be confined to that resulting from twisting or bending because of the fall of the shed on its side. The dock is old. For reasons that were sufficient to the engineers in charge of the dock, the foot of all columns inspected on the river side of the shed were free to move as they were not bolted down. As the shed fell away from the river, I do not attach any weight to the theory that the collapse was due to the impact of vessels. W. H. P. CREIGHTON.

New Orleans, Oct. 18, 1915.

Mine-Timbering Methods and Falls of Ground

Sir—In your editorial of Sept. 30 on the subway timbering accidents in New York you refer also to mine timbering and the frequency of rock falls in mines. Although it is true that most of the accidents in mining are due to falls of ground, nevertheless they are very rarely due to failure of timbers as a whole. If they do so collapse, it is for lack of following correct principles.

Square-set timbering, which resembles that in the subway, is braced against the ground it is intended to support. Permanent diagonal bracing in any direction should not be needed as an essential part of the system. When enlarging the open chamber, set by set, there is in each case a short time when the blocking is out. If the ground is unstable, temporary braces or stulls may be necessary to take up the unbalanced pressure of the timbers, and the ground opposite, against the open space. As soon as the timbers are up and blocked against the new faces of ground, the structure is again in equilibrium and the braces may be removed.

This system of timbering may fail from two causes—from excess of pressure either from top or side or from timbers becoming displaced through the failure of blocking.

The first cause has no particular bearing on the subway accidents. In mining, it is usually avoided by decreasing the size of the openings, to take advantage of the arching effect of the ground. Close filling with waste material is almost universally practiced. Large openings maintained on timbers are thus avoided.

The second case is most apt to occur in unstable ground. Therefore when the ground is loose the sets are lagged carefully, and when breaking out for new sets spiling or braces may be used, with special props against loose boulders to hold them in place. They are intended to hold the ground in position and prevent it from raveling away from behind the blocking or timbers, leaving them in the air, when they may fall of themselves or be knocked down by ground sliding in, and perhaps bring the whole stope down with them.

The timber sets are usually 5 to 7 ft. square horizontally, rarely 8 ft., and from 7 to 9 ft. in height, center to center. When accurately framed and well blocked, the timbering has a certain stiffness in itself, which becomes considerable if there is enough pressure to make the timbers "cut down" slightly. It is because of this stiffness that special bracing is not usually necessary in the interval of taking out ground for timbers.

From sketches of the timbering in Seventh Ave. it would appear that the spacing was too wide for it to have any stiffness longitudinally. That was provided only by blocking at the ends. If this is removed from one end, as by blasting, it would require little force—perhaps no more than setting the brakes on a surface car—to knock it down. The structure could have been braced in any number of ways. It is a sad illustration of a too common fault of design to build a framework amply strong to support its load, but brace it so poorly that it fails without developing the safe strength of its members.

The Broadway collapse was from a different cause. The timbering spaces were wide, about 8 ft. in height by 10 ft. in length. Either the cross-timbering was not strong enough to resist the pressure of the slide or the omission of lacing across the wide spaces of the sets (none is shown in the sketches) allowed a small slide to start between them, which would naturally carry down blocking and adjoining timbers with it. It might easily have been both. The cross-struts are long. If a single post broke, it would bring down those over it, the cross-strut at its top and the two longitudinal members against the ground on each side. It is a matter of chance what else might fall down.

There is a tremendous difference in the strength needed to hold ground in place and that necessary to hold it after movement has begun.

The slide might have been prevented by close lagging between the sets or it might have needed more cross-timbers. In any case, it would have been much improved by bracing. The half which remained standing was only saved by the stiffness of its joints.

Something is wrong when a structure fails with only a small proportion of its members broken. It should go down like the "one hoss shay," with each part as strong as the next, but only because of an overwhelming stress. G. S.

Bisbee, Ariz., Oct. 15, 1915.

NOTES AND QUERIES

Difficulty Occasioned by Falling Leaves getting into flumes, and thus into the fine screens in concentrating machinery in the mining section of the far West, leads E. T. Dudley, construction engineer of the Bunker Hill & Sullivan Mining and Concentrating Co., of Kellogg, Idaho, to inquire whether irrigation engineers or firms supplying material for irrigation projects have met and overcome a similar difficulty, and if so, how.

Errata—In the article "Diagram for Determining Pavement Crowns," "Engineering News," Sept. 9, 1915, p. 510, the expressions $\left(\frac{W}{2} + x\right)$ and $\frac{1}{2}\left(\frac{W}{2} + x\right)$, appearing at the right of Fig. 2, should be $\left(\frac{W}{2} - x\right)$ and $\frac{1}{2}\left(\frac{W}{2} - x\right)$. In the first column of p. 510 also the value for "Elevation of left curb' should be 89.67, as shown in Fig. 3, and not 86.67.

Old and New Bear Valley Dams and Crags Dam in Service

By J. B. Lippincott*

Many unusual types of dams have been constructed in southern California for the impounding of flood waters for irrigation purposes. The engineering profession is naturally interested in the physical success of these structures. This is written to record certain tests in service of two of them.

The old Bear Valley Dam in San Bernardino County, California, was built by F. E. Brown in 1885 and was the pioneer in light-arch dams. It was constructed of uncoursed granite ashlar, the stone being of good quality. This dam is curved upstream with a radius of 335 ft. and has a maximum height of 64 ft. Its thickness is but 2.5 to 3 ft. on top and 8.5 ft. at a point 48 ft. below the crest, where it rests on a base of masonry that is 13 ft. wide at this point and increases to 20 ft. The greater pressure occurs at the point where the dam joins this base and amounts to 53 tons per square foot. The dam stood successfully from 1885 until 1913, or for a period of 28 yr., having frequently been subject to full pressure. It was found desirable to increase the storage capacity of the reservoir and a new type of dam was built below the old arch dam as shown in Fig. 2. This latter structure is as novel in its line as the old Bear Valley Dam. The designer was John S. Eastwood (the plan being patented). It was completed in 1910-1911.

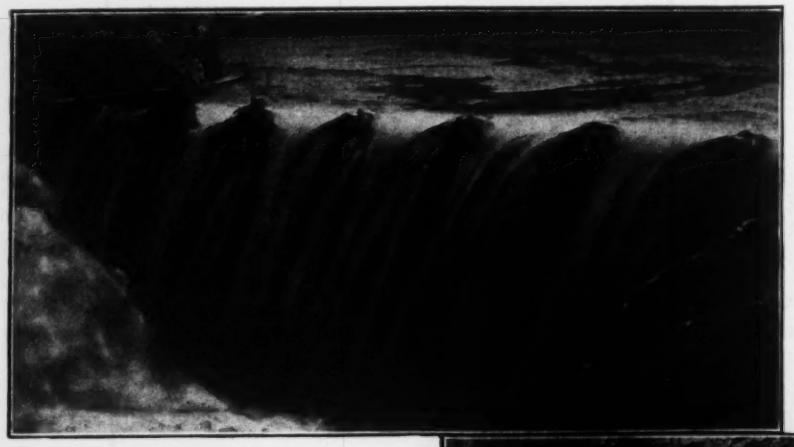


FIG. 1. CRAGS DAM WITH 5-FT. OVERFLOW
Flood of February, 1915. The same flood rose 5 ft. higher than shown

This new dam is shown in the accompanying photographs. There are 11 buttresses 32 ft. apart with 10 arches. The length of the dam is 363 ft.; the maximum height, 92 ft. The buttresses are braced together by struts. There is a spillway on each side through the last arch. These spillways have a capacity of approximately 1,220 sec.-ft. The area of the drainage basin above this dam is 56 sq.mi., of which 28 sq.mi. naturally drains indirectly through Baldwin Lake. The maximum flood runoff from the mountain drainage basins in this section of California is fully 200 sec.-ft. per sq.mi. A feature of this dam is the thin buttress walls, which taper in thickness from 12 in. at the top to 26 in. at the base of the higher sections, and the thin shell of which the arches are composed.

This statement is written to record the fact that this reservoir has lately been filled to the level of the waste-way, the storage capacity having been increased from 26,463 acre-ft. at the old dam to 65,065 acre-ft. at the new dam. The dam is quite tight. There is some little seepage through the concrete, which is led by a pipe through each of the buttresses to the measuring-box and weir, which is located between the two center buttresses. Thus the loss can be accurately determined. With water at the 65-ft. contour the seepage was about 0.1 sec.-ft. The old forms have not been stripped from a large part of the rear of the arches. The dam, which was described in *Engineering News*, Dec. 25, 1913, was built by the Bear Valley Mutual Irrigation Co.

Another unusual test of an arch dam occurred at the Crags Country Club, in Los Angeles County, California. It was built by the club in February, 1913, and was designed by G. O. Newman and Cyril Wigmore. The abutments are volcanic trap. The maximum height is 50 ft. It is 2.5 ft. thick on top and 16.66 ft. at the base at the point of maximum height. Its length is about 149 ft. The spillway is entirely inadequate, which makes the dam of an overflow type. Small boulders were embedded freely in the concrete. The radius of the dam is 287.9 ft., and the load on the abutments 27 tons per sq.ft. with a full reservoir. Vertical 1-in. bars were placed about 4 ft. apart in the structure. Temperature reinforcement in the upper face consists of horizontal bars spaced 3 ft. apart and vertical bars 5 ft. apart. River gravel was used for the concrete (1:6, with a richer

FIG. 2. OLD AND NEW BEAR VALLEY DAMS

*Consulting Engineer, Central Building, Los Angeles, Calif.

mix on the faces). The gravel originates from sandstone and conglomerate beds and is not of first quality.

When the dam was 37 ft. high, the upper concrete being new and the form boards still in place a flood passed over the crest 5.5 ft. deep, tearing off the forms but doing no other damage. In January, 1914, another flood passed over the dam 10 ft. 5 in. deep. In February, 1914, another flood of the same depth passed over the crest without damage. The oldest concrete at the time of the first flood was about seven weeks and the upper 4 ft. not over three days.

The drainage area above the dam is about 30 sq.mi., and the flood of Feb. 24, 1914, is estimated at 3,300 sec.-ft. The view given shows the flood passing over the crest of this dam. Considering the green concrete and the overflow, this is a particularly severe test of the arch type of concrete dam. The structure was not injured by any of the floods.

Internal Stresses in Rails Found To Be High

High stresses exist in steel railway rails even when no train is on the track, as the result of the permanent stretching of the outside metal of the head caused by the rolling action of traffic. The outer layers of the head—on the tread and along both gage side and outside of the head—are stretched by the rolling in a manner directly analogous to hammer peening. Since these outer layers are connected to the interior metal of the rail they are prevented from elongating and therefore are thrown into a state of longitudinal compression, while at the same time a slight tension is produced in the interior of the rail.

The first careful measurements of this action were made by J. E. Howard, engineer-physicist of the Interstate Commerce Commission, in connection with an investigation of a railway accident at Talmage, Iowa, where a train was wrecked by a broken rail. Strips were cut off the faces of the rail and their shortening or lengthening when cut loose was determined by gage measurements of the distance between two gage points marked on the rail a known distance apart before the cutting.

Stresses in the Broken Rail

A section of the rail which caused the wreck showed the following stresses: On the gage side of the head, where the rail showed considerable flange wear, compression of 10,200 lb. per sq.in.; on the opposite side of the head, tension of 6,300 lb. per sq.in.; on the top of running surface of the rail, compression of 2,100 lb. per sq.in. The strip from the gage side of the head, which showed the highest stress, also was found to be quite brittle. This rail was the outer rail on a 2½° curve.

The brittleness of the exterior portions of the head where the rolling action has taken place was established by direct test on this rail. In ordinary tensile tests the metal in the interior of the head showed about 20% elongation (on 2 in.) and something over 30% reduction of area, while specimens from the top of the head or running surface showed an elongation of only about 1% and no measurable reduction of area; a corresponding strip after being annealed showed 15% elongation. The strip from the top of the head had an elastic limit of 100,000 lb., which was only slightly below the ultimate strength of the strip, while the strip from the center of the head had an elastic limit of 55,000 lb., or about one-half the ultimate.

Thin strips from the sides of the head were bent to see what angle of bending they would stand before breaking. The strip from the outside of the head could be bent 56° outward or 78° inward. The strip on the gage side of the head could be bent 44° outward (away from the head), but only 5° inward. In all cases corresponding strips when annealed could be bent to much larger angles, ranging from 56° to 85°. This is in harmony with the result of measurements of the internal stresses, which showed that when a piece of rail is annealed the stresses existing in it are largely eliminated.

Initial Stresses in a Relaid Rail

Another rail, not from the same track, showed the highest stresses on top of the head. Two separate test

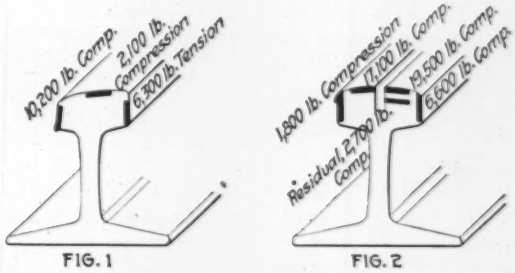


FIG. 1 FIG. 2

PERMANENT INTERNAL STRESSES IN RAILS MEASURED BY INTERSTATE COMMERCE COMMISSION

Fig. 1—Stresses in rail which broke in Talmage wreck.
Fig. 2—Stresses in a relaid rail

strips from the running surface showed compressions of 17,100 lb. and 19,500 lb. per sq.in. The sides of the head both showed compressions—one of 1,800 lb., the other of 6,600 lb. per sq.in. This rail had been relaid, each side in turn having been the gage side. This explains why the peening effect was noticed on both sides of the head.

Another test piece of this rail showed even higher values, the stress on top of the head reaching 21,300 lb. per sq.in. compression. The stresses on the two sides of the head were both compression, respectively 600 lb. and 7,800 lb. per sq.in. In this rail the entire middle part of the width of the railhead was cut out and gradually reduced in height by planing off the under side (nearest the web) and measuring the shortening at different stages of the planing. The computed compressions averaged over the whole strip, when the strip had been planed to various heights, are given in the following table:

Depth, In.	Compression, Lb. per Sq.In.
2	4,500
1½	6,000
1	14,000
½	20,400
¼	21,300
1/10	21,300
12/100	21,300

Thus the very high compressive effect in the head of the rail extended down nearly ½ in. In the center and lower part of the head the stress is in tension, as is necessarily the case, since the sum of the tensions in the rail must equal the sum of the compressions. Other tests established the existence of this tension specifically, though they did not directly give its amount.

Steel Arch Highway Bridge in the Hudson Highlands

SYNOPSIS—Five alternate steel designs and one concrete design were submitted for a highway bridge crossing a gorge making in from the Hudson River in the Palisades Interstate Park. This article illustrates the competitive designs. The one concrete design requested cost almost three times as much as the accepted steel design.

A steel arch highway bridge in the midst of remarkably beautiful surroundings is soon to be erected in the Hudson Highlands for the Palisades Interstate Park Commission. Although the highway which the bridge carries is under state control its location in the park and the desirability of having an artistic and thereby expensive structure led the commission to offer to build the bridge if the state highway department would build the abutments.

The site on which the bridge is to be located offers a remarkable opportunity to the bridge designer who appreciates the artistic side of his profession. The Popolopen Creek gorge is nearly at right angles to the course of the Hudson River and widens rapidly toward its mouth, so that the bridge will be in full view from passing steamboats on the river as well from the railway trains. The tree-clothed sides of the gorge furnish an admirable setting for the structure.

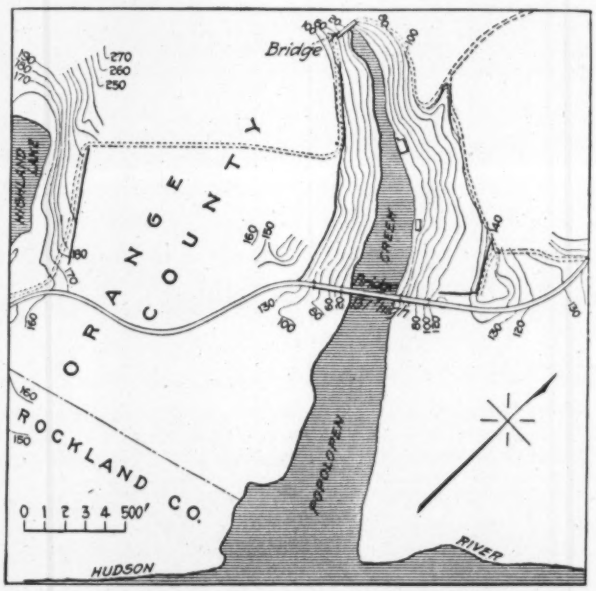
The commission's engineers submitted a profile of the site of the proposed bridge to several well-known bridge companies, with a request for designs and bids, stipulating that bidders should proportion their structures on the basis of Cooper's specifications for highway bridges of 1909, with a roadway loading of an 18-ton road roller and a sidewalk loading of 150 lb. per sq.ft. The width of the gorge to be spanned is 600 ft. at the bridge site. Bidders were left free to choose such spans and proportions as they thought best. As the commission desired to erect the structure of concrete if the cost were not prohibitive, one concrete construction company was also invited to submit a design and bids.

The accompanying drawings show in outline the designs which were offered by the several bidders. All have been redrawn in similar style and are reduced to uniform scale. It should be said in fairness that the extent to which artistic design was of importance in determining the award does not seem to have been clearly understood by all those taking part in the competition. The successful competitor, however, the Phoenix Bridge Co., took special pains to inform itself concerning the conditions at the site. The chief engineer of the company, John Sterling Deans, assigned George Schenck of his staff to make a personal examination of the site of the proposed bridge and sketches of the surrounding country. After this information was obtained, several tentative designs were prepared in the company's office under direction of P. L. Szlapka, its designing engineer. The particular features of the design finally submitted and accepted were the work of Sumner Gowen.

The structure of the Phoenix Bridge Co. is designed for erection as a cantilever. It has two sidewalks and is to carry a permanent roadway with a concrete base and wood-block or other surfacing. The price for the structural steel and hand railing with estimated weight of 1,400,000 lb. was $52,360, not including field painting, concrete roadway or sidewalks.

The design of the McClintic-Marshall Co. was, as shown, a long-span arch. The price quoted was $50,430, which included the erection and two coats of paint after erection, but not the bridge railing.

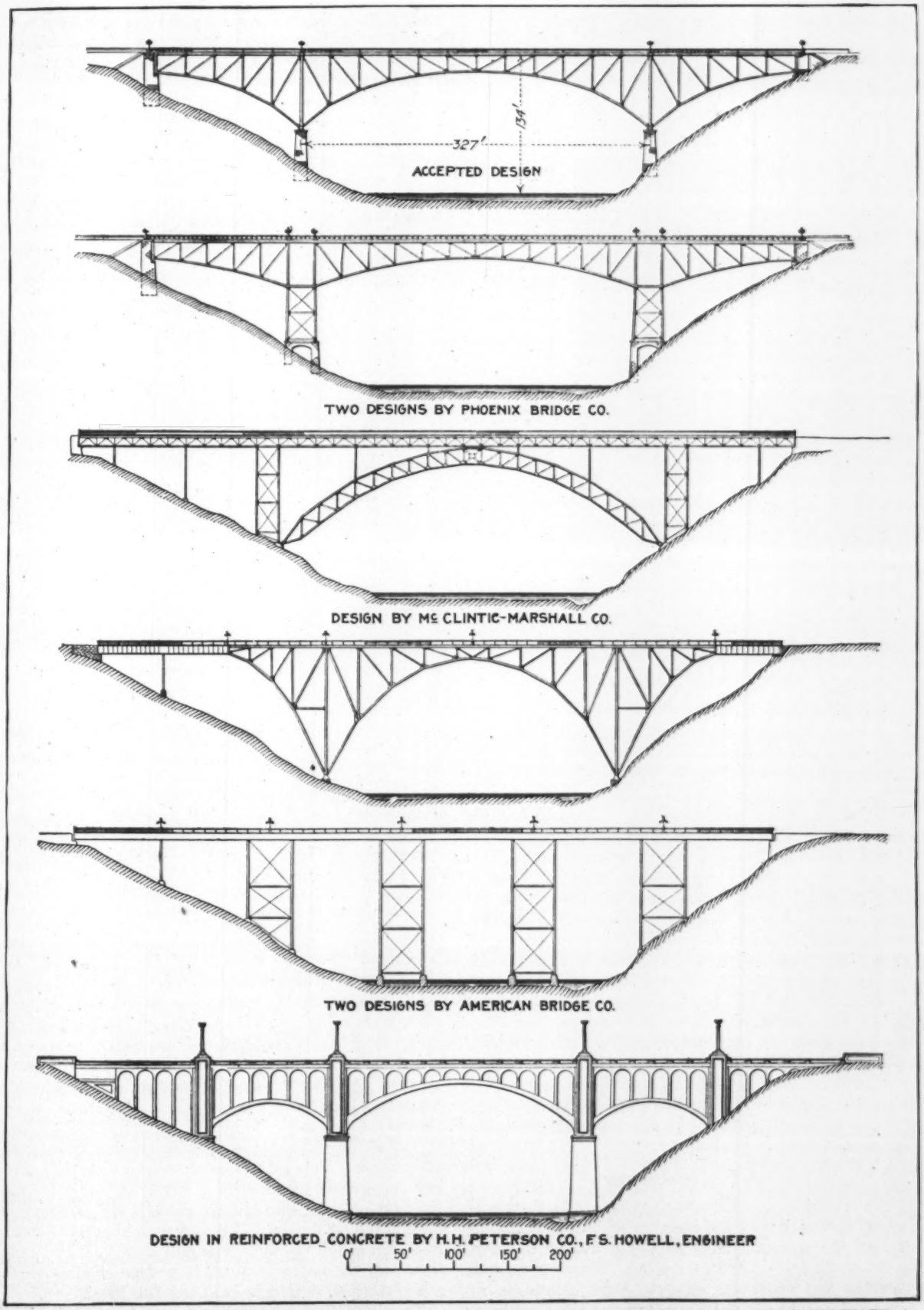
The braced-arch design of the American Bridge Co. was designed to reduce the expense of foundations to the lowest point. The price quoted for this structure was $53,600, which included one coat of paint after erection and the steel railing. This proposal was based on Class A loading of the New York State specifications of 1905, with certain modifications. For the same design



MAP OF SITE OF POPOLOPEN VIADUCT
Note the old and new alignment of the road; new road in full lines, old road dotted

with the trusses proportioned for a uniform load of 55 lb. per sq.ft. and the floor system for 80 lb. per sq.ft., with a concentration produced by a 6-ton wagon, the price quoted was reduced to $46,350. For the alternative design with steel towers submitted by the American Bridge Co., designed for the heavy loading fixed by the New York specifications of 1905, the price quoted was $45,225.

The design for a reinforced-concrete structure was submitted by the Howard H. Peterson Co., of New York City, of which F. S. Howell is engineer. This bridge was designed with a 24-ft. roadway and a 4-ft. sidewalk with a width over all of 36 ft. The total length of the structure is 775 ft., the three arches having spans of 105 ft., 210 ft. and 105 ft. The concentrated live-load assumed was a 24-ton truck. The allowable tension in reinforcing steel was taken at 16,000 lb. and compression in concrete, 700 lb. The price bid, including the piers with foundations carried to bedrock, was $139,000. This price included also the concrete roadway slab and Topeka-mixture paving on concrete base for the roadway.


327'
134'
ACCEPTED DESIGN
TWO DESIGNS BY PHOENIX BRIDGE CO.
DESIGN BY McCLINTIC-MARSHALL CO.
TWO DESIGNS BY AMERICAN BRIDGE CO.
DESIGN IN REINFORCED CONCRETE BY H.H. PETERSON CO., F.S. HOWELL, ENGINEER
0' 50' 100' 150' 200'

DESIGNS FOR THE POPOLOPEN CREEK VIADUCT NEAR WEST POINT, N. Y., FOR THE PALISADES INTERSTATE PARK COMMISSION OF NEW JERSEY AND NEW YORK

Railway Bridge and Building Engineers in Convention

The twenty-fifth annual convention of the American Railway Bridge and Building Association, held at Detroit on Oct. 19-21, was a successful meeting in its large attendance (165 members and over 85 visitors) and in the character of the reports and discussions. The president is G. W. Rear (Southern Pacific Ry.), San Francisco, Calif.; secretary, C. A. Lichty (Chicago & Northwestern Ry.), Chicago. The next meeting will be held at St. Paul, Minn.

Concrete bridges, piles and culvert pipe were covered by two committee reports, which were of considerable interest. The report on bridges dealt with construction rather than with design, and with structures of moderate size. It included a compilation of the details of practice on a number of roads in regard to such matters as concreting plants, placing concrete during cold weather and the spouting of concrete. As to the last-mentioned matter, most railways use this method with more or less restriction, but three railways do not permit its use at all.

A special feature of the report relating to concrete piles was the information regarding the extensive use of concrete trestle bridges. These have piles and caps (or sometimes thin piers), carrying slab spans on which the ordinary ballasted track is laid. As to concrete culvert pipe, some roads make these pipes of such great size (oval section, 84x89 in.) that they are used for cattle passes. It was suggested that concrete pipe culverts with cemented joints have great strength to resist any tendency of the bank to separate them.

Timber Trestle Bridges

That the timber trestle is still a very important feature of American railways was evidenced by the long and active discussion of the report on this subject. The report and discussion both related mainly to the deck rather than to the structure as a whole. The committee considered that in spite of the objections to boxing the guard timbers over the ties no better means of holding the ties in place has yet been perfected. Several members, however, considered that spacing blocks are more efficient, although they did not propose to omit the boxing of the guard timbers even if the blocks are used. The blocks should be placed under the guard timbers.

The more general use of solid-deck trestles with ballasted track was recommended, because of their economy, although the first cost of such a structure of creosoted timber is about 50% greater than that of an ordinary trestle of untreated timber. The report suggested a layer of felt-and-pitch roofing to prevent water from getting through the deck to the lower timbers, but few railways seem to consider this extra expense necessary. The use of rerailing devices at the ends of high trestles was advocated by one speaker.

Locomotive Cranes

The extensive use of locomotive cranes is a feature of railway and other work and includes not only the handling of material in innumerable ways, but also such special service as piledriving and excavating. Handling concrete materials and depositing concrete, erecting bridges, renewing ties and rails and unloading and handling heavy freight are examples of the uses of the crane. It may also handle a dragline or grab bucket or a piledriver (with or without leads), and may be so arranged that a dipper handle or a horizontal truss frame and leads may be attached, converting it into a steam shovel or a railway piledriver of long reach. The crane may not work as cheaply as a regular piledriver or steam shovel or dragline excavator, but its advantage (and often economy) comes from its ready adaptability to such uses where a regular machine is not available and where the amount of work of any one kind is too small to warrant the employment of the latter, while the time and cost of doing the work by hand would be considerable.

The machines are of two general classes—the eight-wheel crane, which may be operated in trains and on main-line work, and the four-wheel crane for yard and shop use.

Railway Water Tanks

It has been assumed very frequently that wrought-iron tanks are more durable and economical than steel tanks, but the committee suggested that it is a question whether the wrought iron of today can be compared with that of several years ago. Present conditions appear to justify the continued use of steel rather than a return to wrought iron. An alloy steel with much greater resistance to corrosion than the ordinary metal and of little higher price is a possible development. As to the form of tank, the hemispherical, elliptical and conical bottoms have eliminated the use of the ordinary supporting towers for steel tanks, and the committee advocated the conical form as being more satisfactory in precipitating suspended matter.

Wood tanks continue to be used extensively, but a limiting size is about 20x30 ft. (100,000 gal.). If a greater capacity is required, one steel tank is more economical than two wooden tanks. Flat hoops were considered preferable to round or half-round hoops. The committee suggested the omission of the tank roof in warm climates as being unnecessary (if the water is not used for drinking). Birds get in and build nests and cause more pollution than would occur in an open tank. Nothing was said, however, as to the question of evaporation in an open tank in hot and dry climates. Covered tanks are the general rule, and no cases of the exceptional use of open tanks were given in the report or discussion.

Miscellaneous Reports and Papers

An excellent report was presented on the important subject of "Efficient Methods of Handling Work and Men." It showed how the railway field may be made more attractive to the younger men and how efficiency and economy may result from the proper training of men. As a rule they are employed and then left to find out as best they can how work is to be done and what is required of them. Another important advantage of efficient training is that it develops a supply of men competent for employment as foremen. Methods of keeping efficient records of cost of individual pieces of work were reviewed in another report. This led to some discussion as to difficulties in keeping costs low on railway work. A contractor may purchase material whenever he needs it and can vary his force to suit conditions, but the engineer or superintendent in charge of railway work is usually hampered by restrictions and the necessity of making requisitions even for minor matters, so that he has not a free hand.

Two individual papers were presented. One by C. R. Knowles (Illinois Central R.R.) on "Water Waste,"

showed the innumerable ways in which water is wasted in shops, coach-cleaning yards, engine ashpits, etc. The other, by F. E. Weise (C., M. & St. P. Ry.), was on "Manila Rope." This paper dealt with the manufacture, use and care of rope and pointed out that the substitution of wire rope for hemp rope occurs only in certain lines, while there is an increasing field for the use of hemp rope.

B. J. Arnold States Principles of Utility Valuation

B. J. Arnold, consulting engineer, of Chicago, who perhaps is best known for his numerous street-railway valuations, delivered an address before the recent convention of the American Electric Railway Association at San Francisco. The title of the address was "Foundation Principles of Utility Valuation, with Special Application to Resettlement Plans," and he discussed valuation primarily for resettlement franchises and not for rates. Twenty-five distinct points were presented, and they can best be summarized in Mr. Arnold's own language as follows:

1. The valuation of utilities is still in a developmental stage, without the fundamentals agreed upon by representatives of either capital or the public.
2. The fixed fare of city lines involves as much of a rate problem as any other utility. Rates, service and return are elemental and coördinate factors.
3. Intangible or nonphysical values are receiving more and more recognition, including past losses on a fair actual investment.
4. Historical development and predictions for the future are becoming essential in the comprehensive study of values.
5. Detailed inventory is apparently essential to acceptance by courts and commissions.
6. Every valuation should be so presented as to be readily checked by a competent authority. Elimination of essential details is not in accord with proper procedure.
7. Definite construction schedules should be assumed in reproducing the property, estimating carrying charges and computing life.
8. Fluctuating commodity prices should be averaged over a term of years, using trend prices or the weighted average.
9. Reproduction cost new should consider original as well as present conditions of construction.
10. Appreciation cannot be held to offset depreciation, as a general principle. It may be computed as well as depreciation if necessary.
11. Overhead percentages of from 15 to 25% total in addition to the bare inventory are to be considered reasonable elements of the cost new of a physical property.
12. Franchise values can only be based upon definite contractual relations. Adequate service as defined by public rights thereunder is essential to the computation of correct franchise values.
13. Cost of attaching the business or going value can be definitely computed only where accurate records have been preserved.
14. Renewal funds and amortization of intangible values are a first and prime condition of the permanency of investment.
15. Depreciation expense (renewals) is an operating cost to be provided for by a definite monthly reserve or appropriation, compounded.
16. Renewal funds should be invested, and preferably put back into new property, in order to secure the maximum compounding effect.
17. The simple straight-line method of depreciation, compounded, serves all essential purposes.
18. Maintenance and renewals appropriations should be consolidated in one fund wherever possible.
19. All resettlements should be made on the basis of a continuing investment, carrying permanent funded debt irrespective of ownership.
20. Amortization may then be confined to the intangible values, not to the funded property.
21. Fair rate of return should be dependent upon the risks involved, and should increase with the risk.
22. Valuation and rates is a problem of the second and third generation, not alone of the present.
23. Sliding scale of fares and return best meets conditions of maximum productivity.
24. Resettlement valuations are of the maximum ultimate importance at present. The industry should support fair methods, not oppose all valuations.
25. The electric-railway industry should meet new conditions with the weapons of publicity, standardized accounting and friendly coöperation with the courts and commissions.

Cleveland Municipal Electric Costs Near Estimate

The new municipal electricity works of the City of Cleveland has made great strides in the development of its business. Although its load is only half developed, it shows a cost of current generated of 1.83c. per kw.-hr., compared with 1.25c. estimated under full load. Details are given in "Municipal Lighting Bulletin No. 2," which has just been issued. As promised by F. W. Ballard, Commissioner and Chief Engineer of the Department of Public Utilities, it gives a complete description, with costs, of the new 20,000-kw. municipal electric station and distributing system. It has also a detailed statement of earnings and expenses to Sept. 1, 1915.

The construction costs are as follows:

Main station	$1,137,396
Four substations	194,996
Electric distribution lines	1,079,757
Steam distribution lines	10,623
Office and miscellaneous	41,109
	$2,463,881

The generating station shows the very low unit cost of $56.87 per kw. of capacity. Its generators have a continuous rating of 20,000 kw. Alternating current is transmitted to substations at 11,000 volts and distributed at 2,300 volts. The substations cost on the average $11.82 per kw.

The estimated unit costs of generating and distributing current, made up before the plant was completed were as follows (in cents per kilowatt-hour): Generating, 0.50; distributing, 0.70; administration, 0.05—total, 1.25. This was based on a 40% load factor and 60,000,000-kw.-hr. annual output. The plant has already acquired about half its full connected load and has a daily load factor (ratio of average to maximum power) of more than 60%. The plant load factor (ratio of average daily power to full-load capacity) is 21%—higher than in many old lighting plants. The unit costs of generated current are at present as follows (in cents per kilowatt-hour generated): Operation and maintenance, 1.90; fixed charges, sinking fund and interest, 0.74—total, 1.83.

When the figures for the full year are available there is expected to be an even better showing. Moreover, the municipal plant has been loaded with a $200,000 "whiteway" business-street lighting system. Revamping the old distribution lines has been charged to maintenance, though in part it might have been a legitimate charge against new construction. Extraordinary depreciation to the extent of $119,013 is to be charged to surplus at the end of 1915, but does not enter the figures quoted. This depreciation is due to closing down two old small generating stations.

The number of customers is now 14,500. The total revenue from sales of current for eight months of 1915 was $313,800. The average sale price on the basis of kilowatt-hours sold (14,981,595) was 2.09c. On the basis of kilowatt-hours generated (16,846,250) it was 1.86c.

News of the Engineering World

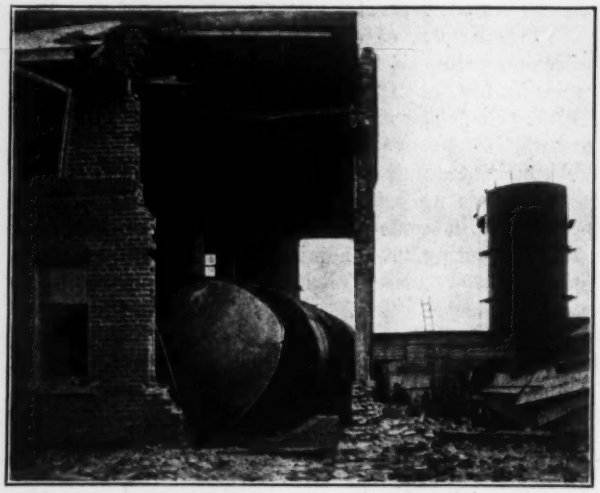
State Will Inspect Shopwork on Highway Bridges

The Illinois Highway Department will in future carry on the bridge-shop inspection for all steel bridges built under plans prepared by the department. William M. Marr, chief engineer of the department, issued notice to this effect during the past week, and requests bridge shops to notify the department several days before material is ready for inspection, so that an inspector can be sent. The department's specifications cover the details.

Municipal Water Tank Bursts Under Air Pressure

By Willis Chipman*

A water tank in Canora, Sask., burst on Sept. 23 while being filled with water. The unfilled portion of the tank contained air under pressure. This accident crippled the fire-protection system of the town and damaged the electric-lighting plant (in which the tank was located), as shown in the accompanying view. A half-dozen rivets



RESULTING DAMAGE FROM BURST WATER TANK

pulled through the metal of the shell, but the remaining rivets held. A strip was torn from the end of the shell through the center of the rivet holes.

The accident was caused by a badly corroded release valve and a tension spring filled with rust. This valve was so placed that the waste or overflow from other pipes discharged over the top of the valve, which caused the heavy corrosion. The pressure gage was badly corroded and is reported to have registered but 40-lb. pressure, in spite of the fact that the release valve was set at 100 lb.

This tank, 9 ft. in diameter by 30 ft. long, formed a part of the "Hoosier High-Pressure System," which was installed in 1912 for fire protection only. Similar systems have been put in for fire and domestic supply by the corporations of Yorktown, Wilkie, Melfort and Old Battleford, Sask. The town of Canora now has under construction a more complete system of water-works (designed by Chipman & Power). The new plant is about ready for test. The steel standpipe which is being constructed for the new system is shown in the background of the accompanying photograph.

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San Francisco Regrades for Electric Railway

After the San Francisco disaster of 1906 many of the street-railway lines previously operated by cable were converted into electric roads, for which maintenance and operation costs are materially less. A trunk line of cable ran along Market St. and had branches into five different sections of the city. The entire Market St. system has since been converted with the exception of a portion of the Hayes St. road west of Fillmore St., where the grades were too steep for an electric railway. When the cable was abandoned the route of this line was altered, to the detriment of the district immediately west of the incline.

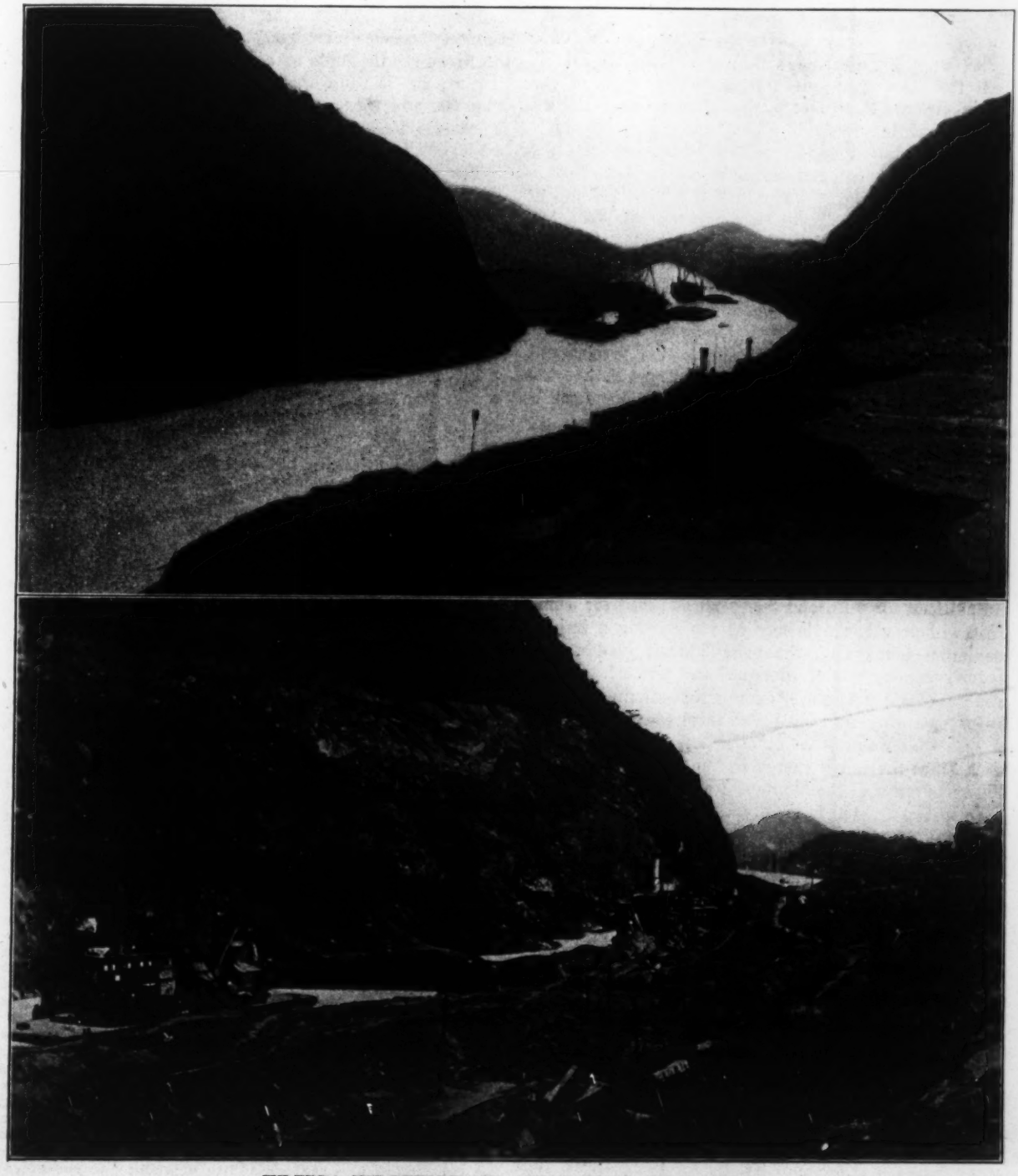
REGRADING HAYES ST., SAN FRANCISCO

A roadway over which electric cars can be operated with safety will greatly benefit this district and improve street-railway traffic facilities. The city engineer, therefore, entered into an agreement with the United Railroads, the holder of the Hayes St. franchise, by which the railway company will at its own expense perform the grading, and the removal and reconstruction of tracks, while the city will pay for erecting retaining walls and terracing the ground adjacent to the cut, as well as to recompense the one property owner who claimed damages from the proposed improvement.

Originally the elevation of the grade crossing at the crest of the hill was 260 ft. above city base. Approaching the summit was a 14.54% grade. When the cut is made the steepest approaching grade will be 10.9%, and the elevation of the crossing at Pierce St. will be reduced to 245 ft. The usual curb takes the form of a retaining wall. Between the sloping grass plot and sidewalk is an ornamental curb.

Panama Canal Still Closed

The Panama Canal slide situation remains unchanged. Every effort is apparently being made to open up the channel through Culebra (Gaillard) Cut by dredges working from both ends, but no official statement has been made as to a date of opening or as to the probability of attacking the slides by any other method than dredging. At the present rate of progress 1,000,000 cu.yd. a month could be excavated by the dredges. The two views on this page show the extent to which the latest Culebra slide has blocked the canal. The upper view was taken in June, 1914 (just before the commercial opening), and is looking south from the west bank of Culebra Cut. In the near background on the left dredges are working on the Cucaracha slide, which was finally cleaned up in January of this year. In the left foreground is Gold Hill, where in October, 1914, the big Culebra slide started. The lower view, taken in September, 1915, shows the blocked canal at the same point after the present slides—both from Gold Hill on the left and Contractors Hill on the right—had closed the Canal.



CULEBRA CUT BEFORE AND AFTER THE LATEST SLIDE
Upper view, June, 1914; lower view, September, 1915